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SOME CONSIDERATIONS FOR THE PHYSICIAN IN INDUSTRY*

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THE value of medical service in industry was emphasized when state compensation laws, which rendered it compulsory to provide medical and surgical treatment for injured workers, became effective. Medical and surgical preventive work proved itself of value and demonstrated that early attention to trivial accidents and injuries reduces the amount of time lost both by the employer and the employee. Further experience showed that improved working conditions notably reduce absenteeism among employees. It also showed that conditions inimical to the health of workers could be removed with the assurance that general physical and mental health would be benefited, resulting in increased production and lessened turnover. In other words, it has been established that proper health instruction to workers pays in enhanced efficiency, besides fulfilling important humanitarian considerations.

The importance of the foregoing is about to become amplified through the adoption of laws providing compensation for industrial diseases. The states of Ohio, Massachusetts, California, New York, Wisconsin and Connecticut have already adopted such legislation, and it is indicated that other industrial states will rapidly follow their example.

WORK AND STATUS OF PHYSICIAN IN INDUSTRY

Supplementing the former concept, the work of a plant physician should reach all departments and all activities of the organization. The physician who limits his activities to the plant dispensary is found to be relatively of little value to the industry with which he is associated. It is only as his influence reaches into the operating departments that the fullest measure of his service is realized. Coexistent with his curative and preventive activities should be a desire to see that men are placed at work for which they are physically qualified. The only method possible of obtaining this end is through the physical examination of workers and applicants for employment—not only is the applicant's physical condition determined but his

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mental attitude as well is considered. His reaction toward industry in general, and particularly toward the job which he is seeking, can be gauged with a fair degree of accuracy concurrent with the physical examination.

The study of processes and job requirements brings to light the degree of hazard present in different operations and suggests protective measures to meet each situation. Certain hazards will, of course, remain concealed until cases of accident or illness bring them sharply to the attention of the superintendent through the medical department, but it has been found that most of these hazards, especially those of major character, are revealed when exhaustive studies are carried on from the viewpoint of the plant dispensary. With a physician or staff with experience, discretion, and the best interest of the employer in mind, this work is so carried forward that rejections and recommendations incur little or no criticism. Rejections in many plants are based on the following:

Organic disease including uncompensated heart disease, disease of the circulatory system, stomach, liver, kidneys, etc.

Loss of or defective vision.

Deafness or disease of the ears likely to lead thereto.

Diseases of the nervous system.

Hernia, unless operated upon or unless the company is released from legal responsibility.

Communicable disease.

Amputations.

Defective mentality.

Candidates should be classified as follows:

1. Individuals physically and mentally fit for any job
2. Individuals physically fit for any employment but below par in development or by reason of minor defect, who by treatment may be placed in Class 1.
3. Individuals fit for limited employment when certified to by the plant physician.
4. Individuals unfit for any employment.

It should be made clear to candidates that physical examinations are not designed to eliminate the defective, unless his employment would be dangerous to the organization, but rather to lead him to remedy his defects for mutual benefit.

Notwithstanding this broad basis for the existence of the industrial physician as such (a misnomer, by the way), the question has been raised and debated as to the status of the physician in industry. Certain eminent authorities, active in association work as well as in universities, have dismissed the suggestion that industrial medicine or surgery is a distinct specialty, with a more or less flippant assertion that industrial medicine and surgery are nothing but good medicine and surgery in industry. It is conceded that nothing short of the very best trained men have any right in the field. It is contended, however, that the very group of high authorities who have denied the physician in industry the right of special grouping and recognition have signally failed in giving to the industrialist, whether he be employer or employed, that prolonged period of economic productivity which special knowledge and responsibility place upon a physician in industry. They have not contributed to the study of the hazards of the occupation; they have not studied processes; and they have not investigated the various operations, the mechanical appliances or the working environment — subjects fundamentally related to good medicine and surgery. Indeed, in many instances these men were lacking in knowledge of the nature of the product of the plant.

Was it the general surgeon or industrial medicine as represented through its personnel that first recognized the opportunity for the rehabilitation of the

disabled and crippled soldier? It was the physician in industry, familiar with the enormous wastage of man power, much of which can be charged to the general surgeon in his neglect of physical reconstruction and vocational retraining methods, who created this new field that we apparently must defend.

One might enquire who of these glib critics, many of whom secured their early surgical training by doing so-called accident work, are now in the field. We know full well that many of these men did not leave the industrial field of their own volition, and it may be noted that many of these eminent gentlemen have not been retained in a consulting capacity. Corporations have realized that they were shortsighted in providing medical service of the sort that disregarded the economic, social, educational, political and even moral phases of the worker's life.

Industrial medicine is not simply a field for the ordinary practice of general medicine and surgery; it bears the same relationship to medicine and surgery as do the specialties of gynecological surgery and brain surgery, with their topical limitations, or traumatic or military surgery, with its special pathology and, as Legge has well stated:

> The scope of application of industrial medicine is to the larger group as a unit and it is in this relation that the main endeavors are directed; although individual service is rendered as occasion demands, its special purpose is prevention—the prevention of occupational diseases and accidents. When these two main issues are applied to the whole group, the humanizing of industry is obtained and a crowning victory for society accomplished. To secure the maximum efficiency from the human machine, the industrial surgeon, virtually the human engineer, acts as the agent for stabilizing labor, thereby facilitating production and helping the worker to do a better day's work, prolong the years of his activity and increase his compensation.

The skeptic may see in industrial medicine elements subversive to the best interests of the profession, socialized medicine, the health insurance fetish, or what not There is less danger of exploitation, by faddists, of groups such as ours, gradually acquiring a business training, if only by contact and absorption, than of the profession at large, with its isolation from affairs. It is true we physicians have been remiss in our communal and business obligations. There has been, unfortunately, a dearth of medical statesmanship and business capacity. I quote from a former communication:

> In the volumes of biologic essays prepared by the fellows of Sir William Osler to celebrate his 70th birthday, which lamentably appear rather as a memorial, the British Ambassador presents certain reflections upon the medical profession which are as stimulating and suggestive as they are courteously phrased. More than any other of the great professions, Sir Auckland Geddes says, physicians lack "the spirit of citizenship," the willingness "to bear their share of the burden of the Government." Their devotion to science and to the service of individual healing is paramount; but they do not conceive of these things in their relation to the nation. I have heard teachers in medical schools say that their whole duty to their students was to teach them to prevent disease, to treat the sick and to "understand the method of science." Sir Auckland Geddes denies this, though to do so "seems to me, in my purely scientific moods, almost discreditable."
>
> The forces which determine national progress, and with which a statesman is primarily obliged to grapple, are not recognized in any science to which the physician is trained. They are the forces of "mass emotion," largely blind, inarticulate and groping, yet supreme and indomitable, forces of the racial genius. Just at present there are forces with which the physician, if he could only recognize the fact, is peculiarly qualified to deal, "an emotion of human betterment, finding expression in centers for child welfare, in schemes for housing the working classes, in the establishment of ministries of health, of reconstruction and research." In brief, "we are at present in the power of a world-wide

emotional storm, the full effects of which are not yet manifest," but which will center in the betterment of the nation's health and of the more purely human relationships. Meantime the medical profession, "with brilliant exceptions," is composed of men who are "immature as citizens" and whose citizenship, such as it is, "is as divorced from their technical knowledge as is the citizenship of the speculative builder when he jerry-builds new slums." The world is "moving on to the greatest of its revolutions," but the majority of physicians "who might be its far-seeing leaders," are "blind and babbling of industrial unrest."

Throughout a relatively brief but active relation with the medical profession it has been observed that the individual doctor has been so occupied with the specific case that he has all too frequently permitted others to direct the social, economic and professional adjustments that modern progress has made necessary—this, notwithstanding that the professional interests and those of the public are identical and should be solved and applied only by a socially-minded medical leadership. The present day is intolerant of isolation from affairs. With others, the doctors must become active and not only support and direct actively but create those remedies for the ills of society with which he is or should be familiar. Unless medicine does this and makes apparent its group strength before the people, the people will all too frequently be victimized by the various cults and pseudo-medical interests that quickly grasp the importance of public control and especially with legislative and governmental interests.

Science has developed facts that have afforded remarkable opportunity to progress, but, in so doing, serious obligations have been imposed upon the doctor. Changes in health administration have, at times, been radical, perhaps revolutionary, but no more radical and more revolutionary than the changes that have come to our scientific thought. The modern health administration, in asking much, is likewise giving much to the physician. The individualization of health work, instead of threatening the material interest of the doctor, actually benefits him in many ways.

The doctor who accepts employment as a plant physician merely to run a dispensary for emergency service, or to fill his wards for teaching purposes, or to protect the interests of the employer in case of liability claims can hardly be an industrial physician in the strict sense. The greatest shortcoming on the part of the physician in industry from a strictly medical viewpoint is his neglect of research. Investigation and inspection of plants disclose innumerable opportunities for saving measures in illimitable variety. It is true that investigators are born, as a rule, but with the present pace of the world investigators must be trained. Nevertheless, I believe that there are among us enough men with latent research instinct awaiting an arousing opportunity who, with heads up, will see this opportunity when it presents itself.

The study of industrial physiology is a phase of our work which is neglected by all of us, with a few notable exceptions. Industrial physiology has two objects: (1) the purely scientific one of ascertaining how the worker performs his work, the conditions under which he can produce most advantageously and maintain bodily health; and (2) the more practical object of establishing in industry the conditions that are conducive to the maximum output of the plant and the maintenance of the highest power of the worker.

A question which has had the serious consideration of industrial surgeons during the past year is that relating to the full-time physician in industry, wholly aside from the relative value of full-time service versus part-time service both to the employed as well as to the physician in the sense of his progress or retrogression professionally. I refer to the moral responsibility in encouraging young men of the best type to enter industrial medicine through a term of preparation as elsewhere referred to, with the present insecurity of tenure—a fact which has been rudely thrust upon our conscience as well as our consciousness. Notwithstanding the feeling that

full-time men with a hospital connection, if possible, render better service than does the part-time man in general practice, I cannot bring myself to promise a career free from financial worries to which a professional man is entitled; hence, I would hesitate to commit myself until such time as industrial medicine is on a firmer basis than exists today.

Qualifications of Physician in Industry

To meet the present-day requirements of the physician in industry, medical director, or however he may be characterized, a man must have a good general education, must be upright in bearing and demeanor, and must possess tact and judgment. He must have had a sound professional training in a college stressing the great basic foundations of his future work—namely, anatomy, physiology and pathology—a general hospital training of not less than two years, with special attention to surgery during the second year, if he is to be employed in a foundry, mill, shipyard, railroad, or heavy industry. For a position in a store, telephone office or an industry of light operations, training in medicine is probably preferable. In the absence of university training in industrial hygiene, he should have at least five years of general practice.

The future industrial physician should maintain a connection with public health agencies, such as the city health department with its various dispensaries, the general dispensary, and other public medical service, in order to develop the social viewpoint as well as to broaden his professional skill.

He should be capable of making elementary psychological and psychopathic observations, being certain, however, in their practical application, of not confusing the psychopathics of the employer with those of the worker. It is desirable also that he have a knowledge, not necessarily profound, of the following:

1. The fundamentals of industrial relations; these are widely applicable and include applied preventive medicine, accident prevention, and the methods leading thereto.
2. Plant organization. A knowledge of this subject is likely to prove effective in dealing with the problem of labor.
3. Employment methods, including job analysis, special problems relating to the employment of women and children, race problems, and industrial training—apprenticeship and continuation schools for training in particular jobs.
4. Labor turnover and its cost.
5. Hours of work in relation to fatigue and output, including shift systems and rest periods.
6. Absenteeism and security and continuity of employment during convalescence from accident or disease and during slack seasons. In connection with absenteeism a knowledge of follow-up work, especially among new employees and with the injured, is valuable, as is also some knowledge of the replacement of injured and crippled employees.
7. Physical working conditions—such as heating, lighting, ventilation, water supply, toilets, showers, locker rooms, rest rooms, and restaurants—designs and data for the construction and operation of hospitals, and plant beautification.
8. Pensions and insurance—*i.e.*, liability, group, and social.
9. Housing—including a knowledge of the type of house suitable for economic administration, of the cost of living according to local standards, of com-

pany stores and commissaries and of broad methods of raising the standard of employees' living conditions—transportation, and recreational and educational facilities.

As Meredith has recently pointed out, it is time that the doctor realized his concern in the normal human being as well as in the human being sick, and that his ideal should be the human body always well, and his shame the human body sick. It must be realized that the problem of health, like disease, is a medical problem and that, if we have a responsibility to the sick, our responsibility is none the less to the well. We physicians in industrial medicine are seriously at fault in not devoting more attention to increasing our knowledge of the conditions of health.

That which has made America great in industry is her faculty of bringing together energies hitherto rambling and misdirected into a rounded, concrete whole with largely amplified production. The mainspring of production or success is individual action and not state action. Success is nothing more nor less than opportunity to the individual. The enlightened business man of today sees clearly that the measure of his success is almost directly in proportion to the degree of opportunity that his operation creates for others, but of what value is opportunity lacking its essential adjuvant—the individual in good health?

Problems Confronting Physician in Industry

The relationship of the medical department to the organization is a question that is of concern to all of us. Too frequently the activities of the medical department are under the direction of a personnel manager who, in turn, is totally lacking in human understanding and unappreciative of the finer confidential relationships of doctor and patient. Until a group of personnel managers are trained or industrial relations are recognized as having sufficient importance to merit the attention of a high executive, I am definitely of the opinion that the medical department should be under the direction of and answerable to the highest possible executive. This is asserted with full recognition of its unscientific form. This matter has recently been drawn to the attention of the National Industrial Conference Board, and has been received with evident interest and some assurance that the suggestions would have consideration.

Another most important problem confronting the industrial physician is that of standard and accurate records, including cost records. Are we as individuals in a position to justify completely and accurately the expenditure of the funds for the maintenance of the departments for which we are responsible? In no part of our work is the lack of adequate records more evident than in the keeping of morbidity statistics, upon which is based the real proof of the right of existence, that is, the net saving in time lost.

A practical obstacle in the accumulation of useful morbidity statistics in the past few years has been the high rate of labor turnover, and, more recently, the high rate of transfer from one occupation to another and from one department to another in the process of reducing personnel. In most industrial establishments, this latter process seems to be about complete. One cycle of industrial activity and depression has apparently terminated, but a new one has begun. Now that the number of employees in establishments is less, the work involved in record keeping is lessened and the data are more valuable because the

worker stays long enough at one plant to permit observation of what actually happens from a health point of view. The present time is, therefore, opportune for inaugurating the collection of sickness data, even if the present industrial situation necessitates a very modest beginning.

In order to make the collection of such statistics of real value, there should be a clearing house from which publications are issued to a wide field of readers. Probably the widest dissemination could be secured through the Public Health Service, which has already inaugurated a study of some fifty establishments which are submitting the data desired. Through standardization of the statistical methods and terms used by different organizations, and of the records, sickness periods of employees of many plants and groups of workers will be comparable. If each industry will install and maintain records in conformity with the general plan, certain definite advantages can be expected. In the accumulation of records from different factories and for different industrial groups, a basis will be established for the further study of the behavior of specific diseases, the conditions under which they are most prevalent, their seasonal incidence, their possible recurrence in cycles, etc. From the accumulation of such a body of material, as suggested, the normal expectancy of sickness among persons of different age, sex, color, etc., as well as the amount of preventable illness and the effect of certain improvements in conditions, may be ascertained. There are many questions which ought to be studied in addition to the direct relationship between disease and occupations—questions which, as matters now stand, are subjects of speculation only. If the science of preventive medicine in the industrial field is to progress, its statistics must develop. No science can be expected to make much headway without a means of measurement. It would seem that there is not merely a field, but an urgent necessity for co-operative effort in the direction that will afford a real basis for the control and prevention of disease among industrial employees.

I would counsel that your organization, represented here today, appoint a committee to study such records as are now existent or found practicable, and submit your findings to a similar committee of the American Association of Industrial Physicians and Surgeons in order that standardization throughout the field may be effected.

Among other problems that should receive immediate attention by industrial physicians, may I enumerate the following:

1. Define the proper limitations of the industrial physician in relation to general community health activities, also the relations in extra industrial cases of illness or disability to the work of the practitioner in private practice; relationship to hospitals, community dispensaries and diagnostic clinics.

2. Devise a simple method of cost accounting for medical service in industry that would seriously enlist the attention of plant executives, thus, perhaps, making more stable this branch of medicine.

3. Evolve a practical scheme for supplying health service in small plants.

4. Make available for the medical profession at large special methods of treatment and technic which have been used to advantage by individuals or by a group in a more or less restricted territory.

5. Endeavor to produce high types of papers for publication in the official

journal, featuring problems dealing with industrial hygiene and medicine.

6. Further the production of scientific data.

7. Stimulate the active interest of members in national and state legislation having to do with medico-economics.

8. Establish a closer co-operation with the organized industries of different states, and contact with chambers of commerce and manufacturing associations. In this way information regarding our activities could be more easily spread, thus educating a larger group as to the value and progress of industrial medicine.

9. Effect a codification of compensation laws.

10. Create departments of industrial hygiene in federal, state and local health departments. If such departments already exist, what work is being done and what prospects are there of widening their activities?

Conclusion

In the foregoing I have perhaps wandered far afield and have offered several subjects in a fragmentary fashion, with the object of evoking or provoking a discussion that will serve to crystallize our somewhat nebulous views as to what industrial medicine is; and with the further object of indicating that the sound, energetic medical man, who appreciates that industrial medicine is no longer a matter of medicine and surgery or hygiene and sanitation alone, but that it must be widened to include fundamental factors associated with plant processes and the materials used therein, as well as the more personal problems arising out of industrial life, will be of great value to his organization, will command the highest respect of every person in it, will wield a constant influence and, finally, will always find a post awaiting him.

LEAD STUDIES: I. THE ESTIMATION OF MINUTE AMOUNTS OF LEAD IN BIOLOGICAL MATERIAL*

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THE detection of lead when present in minute amounts in biological material is of considerable importance to the clinician and to the investigator in industrial hygiene. Its estimation is especially important to the latter in any experimental study of the mechanism of lead poisoning; to the clinician it is an immediate and exact confirmation of the diagnosis of lead poisoning, the symptoms of which are often confusing. It is remarkable that the methods for the quantitative determination of lead are few, that they are usually restricted in application, and that a great many modifications have been proposed and much criticism leveled at these methods as they now exist. The problem of estimating small amounts of lead is greatly complicated when organic material is also present, for many organic substances mask partially, if not completely, the ordinary analytical reactions of lead. For instance, a milligram or two of lead as chloride in 5 c.c. of blood serum will give no precipitate with potassium chromate and only a slight darkening with hydrogen sulphide, yet this quantity of lead in aqueous solution may be quantitatively precipitated by either of these reagents. Organic material must be completely destroyed, therefore, and experiment has shown that this is a delicate operation involving especial care in manipulation in order to guard against losses. With proper precautions, however, exceedingly small amounts of lead—1 part in 10,000,000 in urine, for instance—may be positively identified.

A search of the literature shows that the methods most frequently employed for the estimation of small quantities of lead are (*a*) the colorimetric sulphide method; (*b*) gravimetric or volumetric sulphate, molybdate and chromate methods; and (*c*) the electrolytic method, in which lead is estimated as lead dioxide. The literature is particularly rich in criticism and modification of these methods as applied to the determination of lead in different kinds of material (1), and no one method can be applied with equal accuracy under all conditions.

Zeller, in 1707, used an extract of orpiment and lime water—which would contain soluble sulphides—as a means of detecting lead; and hydrogen sulphide as a reagent in analytical chemistry was first proposed by Fourcroy and Hahnemann, who used water acidified with hydrochloric acid and saturated with hydrogen sulphide as a test for lead (2). Pelouze (3), however, in 1842 was the first to propose a colorimetric method for the determination of small amounts of lead. He converted it into the sulphide and compared the intensity of the brownish coloration produced against standard lead solutions similarly treated. A great many modifications

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of this simple method have been developed, particularly for the estimation of lead in drinking water, wine, beer, drugs, etc. It has also been proposed as a means of estimating the amount of lead in factory dusts, etc. (4).

The usual way in which this determination is made is to add a soluble sulphide, such as sodium or ammonium sulphide, to the solution containing lead and then to match the intensity of color produced against that in solutions containing known amounts of lead, the comparison usually being made in Nessler tubes (5). One objection to this direct method is that, in the presence of alkaline sulphides, iron sulphide is formed. If, on the other hand, in order to avoid this, the solution under examination is acidified by the addition of hydrochloric or acetic acids, low results are obtained owing to the slight solubility of lead sulphide in acid solution. This may be avoided by first converting the iron into a complex cyanide by treating the solution with ammonia and potassium cyanide. The iron complex thus formed no longer interferes by giving a coloration with the alkaline sulphide (6). Wilkie (7) has found, however, that if the iron is present as a ferric salt, it is not converted in this way into a compound unaffected by the alkaline sulphide, and that it is necessary to convert the iron to the ferrous state, preferably by means of sodium thiosulphate, before adding the ammonia and potassium cyanide. The method has been employed somewhat similarly by Teed (8), Budden and Hardy (9), and others (10).

In order to avoid the effect of other substances in estimating lead in this manner, several of these investigators first separated the lead from solution by various means, so as to effect a degree of purification. The lead salt was then dissolved in an appropriate medium and the lead colorimetrically determined as previously outlined. It has also been found that the addition of glycerin or sugar to the solution gives greater uniformity in tint and slightly decreases the opacity of the solution. In place of the usual standard lead solution, Harcourt (11) recommends the use of a standard solution made of the sulphates of copper, cobalt and iron.

A number of objections have been found in the application of the colorimetric method of estimating lead as the sulphide. For instance, the physical condition of the lead sulphide at the time the color comparison is made is very important. This is determined by various factors — acid concentration, amount and character of the salts present, etc. In alkaline solutions or in solutions slightly acid with organic acids, the lead sulphide is present in colloidal condition (12), and the size of the particles to a large extent determines the depth of coloration (13, p. 168). Calcium salts in the solution are much more active in coagulating the sulphide than sodium or potassium salts. According to Woudstra, the solution must be colorless before precipitating the lead sulphide, and the standard and the solution to be compared should contain a uniform concentration of electrolytes.

Since it is difficult to secure a high degree of accuracy with solutions of known lead content, while with solutions containing unknown amounts of lead extreme care must be taken in order to have the conditions of precipitation uniform to secure reliable results, this method presents many disadvantages from the point of view of rapidity of execution. With biological material it is, of course, necessary to ash first of

all in order to eliminate the effect of organic substances.

The sulphate method is usually used for the analysis of larger amounts of lead than we are concerned with here, although it is occasionally used for the estimation of lead in tissues in cases of experimental poisoning (14, p. 330). Within its limits it has many obvious advantages, but it is scarcely applicable to the estimation of very small amounts of lead. In order to separate lead completely from other substances and to secure a higher degree of accuracy, many modifications of the sulphate method have been introduced (15).

Lead sulphate is soluble to the extent of 40 mg. per liter at 18° C. (16) and, while this solubility is greatly reduced by an excess of alcohol and sulphuric acid, an appreciable amount of lead is lost in the ordinary course of manipulation. Schneider (15) found it necessary to use a correction amounting to 6 mg. of lead sulphate per liter of filtrate.

A number of substances such as ammonium chloride, tartrate, acetate, the alkaline chlorides and caustic alkalies increase the solubility of lead sulphate, thereby leading to low results; while potassium salts may give high results, on account of the formation of a double salt of lead and potassium sulphates [$K_2Pb(SO_4)_2$] (17).

In the presence of much calcium, insoluble calcium sulphate is precipitated along with the lead sulphate, and it is difficult to effect a quantitative separation of the two. Usually this separation is effected by the addition of ammonium acetate in which lead sulphate is readily soluble. In this connection, however, it should be remembered that calcium sulphate also dissolves in ammonium acetate to some extent (14, p. 338). These facts make it apparent that the determination of lead as lead sulphate is suitable only for the estimation of relatively large amounts of lead.

As the molybdate, lead may be determined either gravimetrically (18) or volumetrically (19), since lead molybdate is insoluble and lends itself readily to either process. The sensitivity of ammonium molybdate as a precipitant for lead is as 1:800,000, according to Eegriwe (20). There are certain difficulties, however, such as the interference of calcium salts and particularly phosphates, which render this process inapplicable to the convenient estimation of lead in biological substances. For calcium salts and phosphates both give insoluble precipitates with ammonium molybdate, and both these substances are present in large amount in the ash of biological material.

The electrolytic process of lead analysis in which lead is separated either as metallic lead at the cathode (21), or more often as lead dioxide at the anode (22), has been subjected to much investigation. In general, the determination of lead as metallic lead is attended with some difficulty, because metallic lead is difficult to dry for weighing without undergoing some oxidation. However, since lead dioxide may be quantitatively separated at the anode by the electrolysis of a nitric acid solution of lead, this method is extensively used, particularly for the analysis of alloys containing lead. A modification of this method has been devised (Denis and Minot, 22) in which small quantities of lead are estimated by precipitating the lead as sulphide, dissolving the latter in nitric acid and separating the lead electrolytically as dioxide. This in contact with an acid solution of potassium iodide liberates iodine quantitatively and the amount of lead is estimated by titrating the liberated

iodine with standard sodium thiosulphate solution.

Vortmann has found that phosphates and sulphuric acid tend to give low results in the electrolytic determination of lead as dioxide, and for this reason low results would be expected when the method in any of its modifications is applied to biological material. Frankel (21), for example, failed to detect excreted lead in urine by this means, although lead was shown to be present unquestionably by other methods. The fact that it has been advised that this method (at first proposed by the Association of Official Agricultural Chemists for the estimation of minute amounts of lead in baking powders) be abandoned (23), further emphasizes this point. Furthermore, the difficulties of manipulation, when applied to the determination of minute amounts of lead, militate against its use as a routine method.

The most insoluble salt of lead known at present is the chromate. According to Kohlrausch (24), its solubility in water at 25° C. is about 0.10 mg. per liter, while von Hevesy and Paneth (25), who used radium-D as a radioactive indicator, by mixing the latter with a lead salt (from which it is indistinguishable) and estimating the radioactivity of a saturated solution of lead chromate, determined the solubility to be 0.012 mg. per liter. Because of its great insolubility and because of the fact that there are very few interfering substances which would be likely to affect the purity of precipitated lead chromate, this method was particularly recommended years ago by Crookes (26) as a means of estimating exceedingly minute amounts of lead.

Lead may be precipitated and weighed directly as lead chromate, or it may be estimated volumetrically by the method originally proposed by Diehl (27). In the latter method, the lead is precipitated by an excess of 1/20 normal potassium dichromate solution and filtered, and the excess of potassium dichromate in the filtrate titrated with 0.02 normal sodium thiosulphate.

The chromate method has received critical examination and has been modified by several investigators (28), yet its general applicability to the estimation of minute amounts of lead seems to have been somewhat neglected. This may be due in part to the fact that lead chromate precipitated from a concentrated solution of a lead salt, particularly in the presence of sodium acetate—as is usually recommended — tends to be basic in character. This is due to the formation of $PbCrO_4.PbO$ and will, of course, give low results. As is shown below, however, lead when present in small amount and in the presence of acetic acid may be precipitated quantitatively as lead chromate, $PbCrO_4$. In this connection, Cox (29) has shown that the basic salt is completely converted into the normal salt by means of acetic acid.

Certain other metals that are sometimes found in the clinical examination of feces for lead may be sharply separated by the chromate process. For example, manganese, copper, bismuth and barium are occasionally found in feces — manganese and copper as a more or less normal constituent; bismuth which may have been administered medicinally; and barium which is often given as barium sulphate for the purpose of making X-ray examinations. Manganese under certain conditions will give positive results with the electrolytic method, owing to the separation of manganese dioxide at the anode; copper and bismuth will give positive results if the

colorimetric sulphide method is used; and barium sulphate may separate as insoluble barium sulphate in the lead sulphate method of analysis. In the method of analysis outlined below, however, lead may be sharply separated from these troublesome substances.

The method adopted in the present investigation is first to ash the material and to dissolve the ash completely in dilute hydrochloric acid. This solution is then neutralized, very slightly acidified with hydrochloric acid and the lead precipitated as lead sulphide. The washed precipitate of lead sulphide is dissolved in nitric acid, the excess of which is neutralized, the solution acidified with acetic acid and the lead precipitated as lead chromate by the addition of potassium chromate. After thorough washing the lead chromate is dissolved in dilute hydrochloric acid, an excess of potassium iodide added and the free iodine formed by interaction with the chromic acid titrated with sodium thiosulphate solution. The lead is first precipitated as sulphide in order to separate it from calcium and iron, both of which are often present in large amount in the ash. If the attempt is made to precipitate the lead directly as chromate in the original solution, calcium phosphate is usually precipitated when the solution is boiled, and a slight precipitate of ferric hydroxide, which often forms, will cause high results owing to its adsorption of potassium chromate. The precipitation of lead as lead sulphide frees it from these substances, however, and is at the same time both quantitative and expeditious.

Experimental

Experience in the detection of lead when present in organic material has shown that the first necessary step in the process by whatever method the lead is to be estimated is the complete destruction of the organic substance. This, therefore, involves ashing the material either at high temperatures or chemically. In this investigation considerable attention was paid to the question of ashing from the point of view of (*a*) rapidity of execution and (*b*) control of lead losses.

Ashing and Extraction

Originally all solids or semi-solids were dried by baking and then ashed at a red heat in electric muffle furnaces without much regard to the degree of heat or the length of exposure. Because variable results were obtained with tissues containing known amounts of lead, however, it was found that the ashing must be very carefully conducted at a temperature well below full red heat, otherwise part or all of the lead is lost by volatilization. Excessive and prolonged heating may be avoided and the ashing much accelerated by extracting the residue with hydrochloric acid and hot water after carbonizing at a low red heat. The carbon residue is much more easily oxidized after this treatment (which removes the greater part of the lead and soluble salts) than if the attempt is made to burn up all the carbon at the first heating. Inorganic salts greatly hinder oxidation of the carbon and, while their removal apparently complicates the manipulation somewhat, the gain in time more than offsets this and is decidedly apparent in routine investigations. After all the carbon is oxidized, a residue is often found which is insoluble in concentrated acid or even in alkali, unless boiled in the latter for a considerable length of time. This residue is not entirely silica; most often it is lead phosphate. There-

fore, especial pains must be taken to get it into solution. Because of its refractory behavior toward acids, it is quite likely that in certain previous work this residue has been mistaken for silica in many cases and discarded as such. It was found that this residue of lead phosphate is readily soluble in tartaric acid upon the addition of a few drops of hydrochloric acid and may be estimated by this means. Tartaric acid even of good quality usually contains lead and it should, therefore, be carefully tested before use.

In the case of liquids, such as urine, the ashing may be conducted most easily by evaporating 2 liters to dryness with the addition of a small amount of nitric acid. On gentle ignition the residue rapidly burns to a pure white ash. With small amounts of blood, bile or other fluids containing organic matter, the carbon may be oxidized by heating with a mixture of sulphuric and nitric acids in small Kjeldahl flasks. While excellent for small amounts of fluids, the latter procedure is rather difficult to apply to the ashing of tissues. Fatty material in particular is difficult to oxidize by this method. With tissues in general it was found to take much longer than direct ashing in the muffle, required more attention and was generally unsatisfactory.

Method of Analysis

As stated above, the lead is separated as the sulphide in this method and estimated as the chromate. The following procedure is given somewhat in detail, because many seemingly trivial points are really worthy of careful attention. Their importance is more apparent when it is considered that the ratio of lead to other inorganic constituents of the ash is frequently as 1 : 10,000 or more.

The acid solution containing lead and relatively large amounts of calcium, phosphates, etc., should be carefully neutralized before separating the lead as sulphide, since otherwise some loss of lead will occur at this point. The most satisfactory results are obtained by neutralizing with sodium hydroxide, using methyl orange as an indicator, and finally adding just sufficient hydrochloric acid to give a distinct acid reaction. Lead may then be quantitatively separated by saturating the cold solution with hydrogen sulphide. An excess of hydrochloric acid should be avoided, since incomplete precipitation may occur, on account of the slight solubility of lead sulphide in the presence of calcium chloride and hydrochloric acid.

The precipitate of lead sulphide after filtering should be washed with boiled distilled water and dissolved in from 2 to 5 c.c. of concentrated nitric acid. In order to precipitate the lead as chromate, the solution of lead nitrate is boiled in order to expel any hydrogen sulphide, is neutralized with sodium hydroxide and acidified with acetic acid, an excess of potassium chromate added, and the solution boiled. In those cases where a very small amount of lead is present (0.1 mg. or less), it is advisable to allow the solution to stand overnight before filtering. The precipitated lead chromate should be thoroughly washed with warm water in order to remove traces of potassium chromate, and finally should be washed as completely as possible from the filter paper into the flask. The filter paper should then be washed with from 2 to 5 c.c. of 1 : 1 hydrochloric acid followed at once with warm water, so as to remove the last trace of chromic acid. This avoids the error of partial reduction of chromic

acid, owing to filtering the solution through filter paper (30). The lead chromate readily dissolves in the hydrochloric acid, and the lead may be estimated by adding an excess of potassium iodide and titrating the iodine liberated by the action of the chromic acid with 0.005 normal sodium thiosulphate solution. The reactions that occur are as follows:

$$Pb(NO_3)_2 + K_2CrO_4 = PbCrO_4 + 2KNO_3$$
$$2PbCrO_4 + 16HCl + 6KI = 2PbCl_2 + 2CrCl_3 + 6KCl + 3I_2 + 8H_2O$$
$$6Na_2S_2O_3 + 3I_2 = 6NaI + 3Na_2S_4O_6$$

From this it follows that 3 mols of sodium thiosulphate are equivalent to 1 mol of lead chromate, or 1 c.c. of 0.005 normal sodium thiosulphate solution is equivalent to 0.3451 mg. of lead.

The above method effects a very clean separation of lead and at the same time permits the estimation of minute amounts with the minimum sacrifice of time and care in manipulation. Only one carefully standardized solution is required—the 0.005 normal sodium thiosulphate solution. When lead is present to the extent of a few tenths of a milligram only, the accuracy of the estimation may be increased by using a small burette graduated in 1/50 c.c. in place of the usual burette having 1/10 c.c. graduations.

Where there is any question as to the identity of the chromate precipitate in those cases where it is very small in amount (0.05 mg. of Pb, or less), the lead is best identified micro-chemically as the triple nitrate, $K_2PbCu(NO_2)_6$, according to the procedure of Behrens (31).

A modification of this method was developed in which the amount of lead chromate was estimated colorimetrically. Free chromic acid gives an intense red color with s-diphenyl carbazide (32). The lead chromate was therefore dissolved in hydrochloric acid, 1 c.c. of a solution of s-diphenyl carbazide in glacial acetic acid added, the whole solution diluted to a given volume, and the amount of chromic acid determined colorimetrically, using as standards both an acid solution of lead chromate and a solution of pure, re-crystallized potassium chromate. This method is strictly limited to the estimation of very small amounts of lead (1 mg. or less) and therefore lacks the flexibility of the titration method. When applied to the determination of 10 mg. or more of lead, it is far less accurate than the titration method (33).

In order to estimate the degree of accuracy that could be obtained by the titration method, a considerable number of direct analyses were made of solutions containing accurately weighed amounts of pure lead chloride. All the reagents used were carefully purified and the titre of the sodium thiosulphate solution was accurately adjusted by means of pure arsenious acid. The arsenious oxide used for the latter was carefully purified by the method described by Chapin (34). The sodium thiosulphate solution was prepared with water freshly distilled and still warm, and was so arranged that air entering the stock bottle passed through soda-lime and was finally washed with sodium thiosulphate solution of the same strength as the standard solution. In this manner carbon dioxide was excluded and the solution underwent but little change in titre over a period of several months. Table 1 gives a typical series of results. It will be noted that the average absolute error of these analyses is 0.02 mg. and that the average percentage error is 2.2 per cent. This corresponds to the titration error, since one drop of the sodium

thiosulphate solution is equivalent to 0.02 mg. of lead.

Several incidental questions were considered in the application of this method—such as the effect of an excess of potassium nitrate on precipitated lead chromate, the solubility of various lead salts (particularly lead phosphate) in tartaric acid, and the solubility effect of sodium acetate in contact with lead chromate. Mertens (35) has noted the solvent action of calcium chloride and hydrochloric acid on lead sulphide and, as this is an important point in connection with the quantitative separation of lead as the sulphide, the experiments contained in Table 2 were made. The results show that the slight solubility of lead sulphide is not due to calcium chloride alone, nor to a small amount of hydrochloric acid alone, since in each case the amount of lead recovered was within the average experimental error. With 1 c.c. of hydrochloric acid and 5 gm. of calcium chloride, however, the recovery amounted to 86 per cent., while with the same amount of calcium chloride and 5 c.c. of hydrochloric acid the recovery was only 45 per cent. of the total amount of lead present. It is necessary, therefore, to avoid an excess of hydrochloric acid when separating the lead as sulphide, for some calcium salt will be present invariably in the ash from tissues. For this reason the solution of the ash in hydrochloric acid is first neutralized and then only sufficient acid added to give a distinct acid reaction to methyl orange.

TABLE 1.—ACCURACY OF TITRATION METHOD

Experiment Number	$PbCl_2$ Solution	Lead Present	Lead Found	Absolute Error	Percentage Error
	c.c.	mg.	mg.	mg.	
1	12.31	1.23	1.20	0.02	1.6
2	12.58	1.25	1.22	0.03	2.4
3	8.53	0.85	0.89	0.04	4.7
4	15.63	1.56	1.52	0.04	2.5
5	3.68	0.36	0.36	0.00	–
6	8.36	0.83	0.84	0.01	1.2
7	11.93	1.19	1.18	0.01	0.8
8	5.08	0.51	0.57	0.06	10.5
9	5.94	0.59	0.60	0.01	1.7
10	11.09	1.11	1.09	0.02	1.8
11	8.13	0.81	0.81	0.00	–
12	8.10	0.81	0.82	0.01	1.2
13	8.33	0.83	0.82	0.01	1.2
14	12.11	1.21	1.19	0.02	1.6
15	12.45	1.24	1.22	0.02	1.6

TABLE 2.—SOLVENT ACTION OF CALCIUM CHLORIDE AND HYDROCHLORIC ACID ON LEAD SULPHIDE

Experiment Number	Lead Present	Calcium Chloride	Acid	Lead Found
	mg.	gm.		mg.
1	1.0	none	none	0.95
2	1.0	1	"	0.99
3	1.0	5	"	0.99
4	1.0	10	"	0.96
5	1.0	15	"	0.99
6	1.0	none	1 c.c. HCl 1:1	0.95
7	1.0	5	½ c.c. HCl 1:1	0.95
8	1.0	5	2 c.c. acetic	0.99
9	1.0	5	1 c.c. HCl 1:1	0.86
10	1.0	5	5 c.c. HCl 1:1	0.45

TABLE 3.—SOLUBILITY EFFECT OF POTASSIUM NITRATE

Experiment Number	Condition of Precipitation	Lead Present	Lead Found
		mg.	mg.
1	5 c.c. HNO_3 neutralized with KOH, acidified with AcOH	2.00	2.03
2	8 gm. potassium nitrate 2 c.c. glacial AcOH	2.00	1.92
3	2 c.c. glacial AcOH	2.00	2.05

Since an excess of potassium nitrate is present during the precipitation of lead chromate, an experiment was made in order to determine the solubility effect of this salt. The results which are given in Table 3 indicate that the solubility of lead chromate is not affected by the presence of potassium nitrate. The precipitate of lead chromate obtained in neutral or very slightly acidified solutions is usually colloidal in character. Potassium nitrate, however, alters the physical condition of the precipitate by coagulating the suspensoid, thus permitting rapid, quantitative filtration of the lead chromate.

Sodium acetate in great excess has some solvent action on lead chromate.

In the ordinary course of procedure a small amount of sodium acetate is invariably present. Experiment, however, shows that small amounts of sodium acetate have a negligible, if any, solubility effect. (Table 4.)

TABLE 4.—THE SOLUBILITY EFFECT OF SODIUM ACETATE

Experiment Number	Amount of Sodium Acetate	Lead Present	Lead Found
	gm.	*mg.*	*mg.*
1	none	1.00	0.99
2	0.20	1.00	1.02
3	1.00	1.00	1.02
4	2.00	1.00	1.00

The application of this method of analysis was tested with a variety of biological material to which known amounts of lead had been added, the material being ashed and analyzed in the manner discussed above. The lead recoveries made, together with absolute and percentage errors, are given in Table 5.

There are scant data in the literature concerning the recovery of very minute amounts of lead by analytical means; the work of Woudstra probably represents the best from a critical point of view. Woudstra has compared his colorimetric sulphide method with Kühn's volumetric method (36) in the estimation of minute amounts of lead in water with the results shown in Table 6.

Even though the recovery of lead added to biological material calls for a great deal more manipulation than the estimation of lead in drinking water, the average error in the analyses of Table 5 is 4.4 per cent., while the average error in the two methods cited by Woudstra is 14.2 per cent. and 10.1 per cent., respectively. It will be noted that the absolute error in the results above (Table 5) is more or less constant. That is, the error is not proportional to the amount of lead determined, and is very largely an end point error. Thus, the error in estimating 0.2 mg. of lead in bile was 0.03 mg., while the error in estimating 50.0 mg. of lead was only 0.14 mg., although there was 250 times as much lead present as in the former case.

TABLE 5.—RECOVERY OF LEAD IN BIOLOGICAL MATERIAL

Material	Amount	Lead Added	Lead Found	Absolute Error	Percentage Error
		mg.	*mg.*	*mg.*	
Urine	1000 c.c.	1.00	1.03	0.03	+3.0
Urine	1000 c.c.	1.00	1.03	0.03	+3.0
Urine	1000 c.c.	2.50	2.58	0.08	+3.2
Urine	1000 c.c.	2.00	1.92	0.08	—4.0
Urine	1000 c.c.	2.00	1.92	0.08	—4.0
Liver	103 gm.	2.50	2.58	0.08	+3.2
Liver	63 gm	2.00	2.07	0.07	+3.5
Liver	100 gm.	2.00	1.94	0.06	—3.0
Liver	76 gm.	50.00	49.86	0.14	—0.3
Muscle	35 gm.	2.00	1.99	0.01	—0.5
Kidney	50 gm.	2.00	2.09	0.09	+4.5
Bile	5 c.c.	0.20	0.21	0.01	+5.0
Bile	5 c.c.	0.20	0.17	0.03	—15.0
Bile	5 c.c.	0.20	0.17	0.03	—15.0
Starch	5 gm.	5.00	4.91	0.09	—1.8
Albumin	4 gm.	5.00	5.07	0.07	+1.4

TABLE 6.—COMPARISON OF VOLUMETRIC PROCESS AND COLORIMETRIC PROCESS (13, p. 175)

Volumetric Process		Colorimetric Process	
Amount of Lead	Percentage Error	Amount of Lead	Percentage Error
mg.		*mg.*	
1.0	— 2.0	1.0	—18.0
1.0	— 1.0	1.0	— 8.0
1.0	—31.0	0.9	+11.1
1.0	—19.0	0.9	— 3.3
1.2	—18.3		

Summary

In this investigation a volumetric method of lead analysis has been applied to the estimation of minute amounts of lead in various kinds of biological material. A number of points regarding the proper means of ashing biological material, as well as the solubility of lead chromate in the presence of various substances, have been investigated and the sensitivity and accuracy of this method have been compared with the sensitivity and accuracy of previous methods.

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SKIN DISEASES COMMONLY SEEN BY THE INDUSTRIAL PHYSICIAN*

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IN the work of the industrial physician many skin diseases are certain to be encountered. The writer has selected a few of the more common of these diseases for consideration in this article, namely:

1. Furunculosis.
2. Acne vulgaris.
3. Impetigo contagiosa.
4. Scabies.
5. Psoriasis.
6. Eczema and dermatitis.
7. Ulcers of the leg.

Furunculosis

According to Stelwagon, a furuncle, or boil, is an acute deep-seated inflammatory, circumscribed, rounded or more or less acuminated, firm, painful formation, usually terminating in central suppuration and necrosis. The symptoms are too well known to be discussed here. The immediate cause is the infection of a hair follicle or sebaceous gland with the staphylococcus aureus. When a series of boils occurs, the condition is called furunculosis; and such a succession of boils often indicates a debilitated condition of the system, any possible cause of which should be sought. Overwork and undernourishment are often causative factors. In every case the urine should be examined for albumin and sugar.

As to the general treatment of boils there is much difference of opinion. Some place great faith in the use of vaccines; among these are Wright (1), Engman, Highman (2), and others. The writer is of the opinion, however, that vaccines are much overrated. Yeast, a very ancient remedy for boils, is again in vogue, the public recently having been educated in this matter by extensive newspaper advertising, and it sometimes seems to be of value. Iron, arsenic, strychnia and manganese are all in use in the treatment of furunculosis, and probably are all of some value when tonic treatment is indicated.

In the past few years still another internal remedy has been used—metallic tin and its salt, stannous oxide. It is an interesting fact that this new treatment was suggested by an industrial condition. Grégoire (3) and Frouin (4), two French physicians, learned that boils almost never occurred among the tin miners in France. They also found that the tin miners were in the habit of giving small amounts of tin ore by mouth to members of their families who were suffering from boils. From this beginning Grégoire and Frouin carried on experiments which convinced them that tin and its salts tend to inhibit the growth of staphylococcus when mixed with culture material in the test tube, and that they have a similar effect in the human body when ingested in small amounts. (Pure metallic tin finely divided: gr. ii, t.i.d., p.c.; pure stannous oxide: gr. ii, t.i.d., p.c.) The writer, after several

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years' experience along these lines, is in agreement with their conclusion.

In the local treatment of the disease extreme cleanliness is important. Frequent washing with soap and water, followed by the application of the following lotion as advised by Bowen (5), is valuable in preventing new lesions by auto-inoculation:

℞
Resorcin .... gr. xv-xxx
Acidi borici .... ʒ iss
Alcohol .... ℥ i
Aquae destillatae .... ℥ v

Poultices should not be employed except for relief of pain. Their use tends to soften the skin, thereby lowering its resistance to infection, and favoring the appearance of satellite boils. When poulticing seems advisable, a mild antiseptic ointment, such as 2 per cent. carbolized petrolatum, should be applied to the skin before the poultice is placed in position. Carbolized ointments should, however, never be used on the fingers or toes when bandages are to be applied, as there is danger of gangrene when this is done.

When the boil "points," a very small incision is usually all that is necessary or advisable. A sharpened hard wood toothpick is often the only instrument needed. In the early stages of a boil such a toothpick dipped in pure carbolic acid may sometimes abort the lesion.

Acne Vulgaris

Acne vulgaris is a disease of the sebaceous glands. Its first stage is the comedo, or blackhead, plugging the orifice of the sebaceous duct. This condition usually begins at, or shortly before, puberty. It is perhaps the generally accepted theory that the comedo is caused by the acne bacillus which produces a hardening of the horny layer of the duct itself leading to its stoppage. The writer cannot accept this theory, but rather believes that the plugging of the ducts is due to purely mechanical causes. At the age at which comedones usually make their first appearance there is a rapid increase in the production of sebum coincident with the advent of puberty. The rapid increase in the size of the sebaceous glands is probably much greater in proportion than the increase in the size of the ducts. The duct may, therefore, be compared to a drain pipe through which slowly moves a thick fluid. If the amount of material poured into such a drain pipe is doubled, the pipe is quite likely to become plugged up, and we do not have to seek further than simple mechanics to explain the cause of such a stoppage.

In the earliest stages of the comedo it is an easy matter to express the sebaceous plug; in fact, at this stage scrubbing with soap and water, if practiced daily, is usually sufficient to establish drainage of the glands. If this drainage is established and kept up there is no further development of the disease, and acne in later years will be avoided. Unfortunately, the comedo stage occurs at just the age when children are most apt to be careless about bathing and, therefore, comedones may continue to form. A year or two later papules develop, each papule representing a sac of retained sebum, dilating the deeper portion of the duct. The pressure of this retained material probably lowers the resistance of the gland to infection, and the ever-present acne bacillus and staphylococcus albus begin to play their parts. The papules begin to change to pustules and we have to deal with a full-fledged acne. At this stage it is certain that rich foods, excess of sugar, consti-

pation and intestinal indigestion may greatly aggravate the existing acne by further lowering the resistance to infection, but it is highly improbable that they play any part in the original causation of acne. Preventive medicine will prove a great success in the treatment of acne when the disease is seen in its earliest stage, for the establishment of drainage of the sebaceous glands will invariably abort the disease.

Treatment of the later stages of acne is much more of a problem; both general and local treatment are necessary. The general treatment consists of general hygiene and treatment directed toward the removal of any probable etiologic factor. If anemia is present, iron and perhaps arsenic may be of value, as may also tin and stannous oxide, used as in furunculosis. As digestive disturbances and constipation are common contributory causes, close attention should be given to their correction through such measures as irrigation of the large intestine in cases of partial colonic stasis, and abdominal massage and exercises for the abdominal muscles. Excess of sweets, especially chocolate, and all indigestible food should be avoided.

In the local treatment of acne, good results are frequently secured by the use of stimulating lotions causing irritation and, later, desquamation. The following is a much used formula:

℞
Sulphuris praecipitati
Spiritus camphorae ....āā ʒ
Alcohol ....ad ʒ ss

Sig.: Shake the bottle and sop on the liquid at night after bathing.

In many cases, hard scrubbing with hot water and *tinctura saponis viridis* as a soap is beneficial. Ultraviolet light used to produce an artificial sunburn with its subsequent desquamation is also often of considerable value. Roentgen rays have been used in the treatment of acne for many years. They are almost certain to produce good results but their use has been condemned by many dermatologists on account of the later undesirable changes which they are capable of producing, atrophy, telangiectasis and pigmented spots having often resulted in the past. Since the advent of the Coolidge tube, it is possible to measure the rays with a considerable degree of accuracy, and in the hands of an expert undesirable changes should rarely or never occur. The effect of the rays is to produce a partial atrophy of the sebaceous glands. Their use seems entirely justified in severe cases which do not respond favorably to the usual methods of treatment.

Impetigo Contagiosa

Impetigo contagiosa is a superficial infection of the skin caused by the streptococcus, although the staphylococcus aureus is usually present as a secondary invader. The primary lesion of the disease is a thin walled vesicle which soon ruptures, its seropurulent contents drying into a crust, which is usually honey yellow in color and has a stuck on appearance. It generally covers a larger area than the lesion which gives rise to it. When the crust is removed a very superficial erosion beneath is exposed, the serous fluid from which is highly autoinoculable. The initial lesion may spread peripherally by undermining the superficial layer of the epidermis or new lesions may continue to appear, autoinoculations from the infectious seropurulent matter.

The diagnosis of the disease is usually not difficult but the annular forms

produced by central healing and peripheral spreading are often mistaken for ringworm. Ringworm, however, almost never shows the amount of crusting commonly seen in impetigo. Predisposing causes of this disease are pediculosis, scabies and dirt. It may occur on any part of the body but is far more frequent on the face, hands and scalp.

The prognosis is always good except in the newborn, in whom the disease is sometimes rapidly fatal. With appropriate treatment children usually recover within a week or two, but in adults the course is apt to be longer.

Treatment of impetigo contagiosa should be directed toward the prevention of new lesions and toward the cure of those present. The greatest care should be taken to prevent the infectious serum from coming into contact with the sound skin. The crusts that are not too adherent should be carefully removed with soap and water. After bathing, the skin should be carefully dried, but rubbing with a towel should be avoided. A mild antiseptic ointment should then be applied, such as:

℞
Hydrargyri ammoniati ....gr. x
Petrolati ....℥ i
M.

Ointments of greater antiseptic strength are apt to cause irritation and favor the spread of the disease.

Scabies

Scabies is a contagious disease of the skin caused by the acarus scabiei. The lesions consist of excoriated papules, vesicles and pustules. The disease most commonly manifests itself on the fingers, hands, abdomen, anterior axillary folds, lower abdomen, thighs and lower buttocks. In females, lesions also commonly occur on the breasts; and in males, on the penis. The face and scalp, except in very young infants, are not involved. Besides the lesions mentioned above, burrows are often present, usually between the fingers or on the palms. They are caused by the female acarus which makes her way into the horny layer to deposit her eggs. These burrows are ordinarily not over half an inch long and as a rule they are seen as tortuous dotted lines, at one end of which may sometimes be observed a gray speck at the site of the mite.

It is a common but erroneous belief among physicians in general that the symptoms of scabies appear almost immediately after exposure. As a matter of fact it is usually weeks, sometimes more than a month after exposure before there is any considerable itching, and it is often another month before the itching is severe enough to cause the patient to seek treatment. This is especially true in persons of cleanly habits, for frequent bathing with soap and water, while never curative, will result in a delayed development of the disease.

In the diagnosis of the disease, the history is often of much importance. In many instances when negative answers are given as to recent exposures, a definite history may be obtained of the patient having slept with an itching person a month or six weeks before the eruption began. Burrows should be looked for, and when found they are diagnostic. Then the history of itching, especially at night just after retiring, and, lastly, the characteristic distribution of the lesions should make the diagnosis plain.

External treatment alone is all that is necessary in scabies. Sulphur is the principal drug in use. Balsam of Peru and beta-naphthol, however, are often of value alone or in combination with

sulphur. The following ointment is efficacious and usually not too irritating in adults.

℞
Sulphuris praecipitati ....ʒ ii
Beta-naphthol ....ʒ i
Balsami peruviani
Petrolati ....āā ℥ i
M.

It should be applied all over the body below the neck on three successive nights, after a prolonged hot bath and scrubbing with soap. After three nights of this treatment the disease is usually cured. The sheets, night clothes and washable day clothing should then be boiled, and the parts of the outer clothing coming in contact with the skin should be pressed with a hot iron.

Before treating a patient with scabies careful inquiry should be made as to other members of the family, for often the entire family will be found to be in need of treatment. If the patient sleeps with another person, this person should always be treated whether or not symptoms of the disease are manifest.

After three nights' treatment as outlined above, the patient may still complain of itching. This itching is due to irritation of the skin from the ointment and may be relieved by antipruritic washes or starch baths. If there is to be a relapse of scabies or a reinfection, it probably will not occur for several weeks; in any case, a repetition of the treatment for scabies is not advisable until at least three weeks have elapsed since the previous three day course of treatment, on account of the danger of producing severe dermatitis.

Psoriasis

This disease is a scaling dermatosis usually chronic. As a rule it first shows itself in youth or in early adult life, though it may begin at any age. The primary lesions are tiny red papules surmounted by silvery scales. These lesions may increase in size and number until they are scattered over a large part of the body, or they may remain limited to a few areas, such as the region of the elbows and knees which are favorite locations for the disease. The scalp also is a common site.

Psoriasis when widely distributed may resemble a scaling papular syphilide, but the scales of the latter rarely have the silvery appearance of psoriatic scales. Other signs pointing to syphilis, constitutional symptoms, mucous patches, condylomata, history of a chancre, etc., should be carefully looked for in doubtful cases, and a Wassermann test should be done.

The etiology of psoriasis is a mystery. There are two main theories: one, that it is infectious; the other, that it is caused by a disturbance of nitrogen metabolism.

The treatment of the disease consists of regulation of diet, internal administration of drugs, and external measures. Dietary restriction of proteids which is in great favor with some authorities, notably Schamberg, is of doubtful value. It is true that starvation often tends to clear up the lesions, but permanent benefit is seldom obtained. Acute illnesses with fever of more than a week's duration also cause temporary improvement as does severe hemorrhage, but the induction of these conditions is not advisable in treatment.

A simple nutritious diet should be advocated. Alcohol should be forbidden. As to drugs, arsenic is usually placed first. It is only of occasional value, however, and more often has no effect on the disease. Externally, perhaps the

most valuable drug is chrysarobin, but it is not always well tolerated, and dermatitis from its use is frequent. Ointments of from 2 to 3 per cent. chrysarobin often give better results than those of higher percentage. One disadvantage in the use of chrysarobin is the fact that its stains on clothing cannot be removed. Moreover, it stains blond or white hair and is, therefore, rarely used on the scalp. It is also wise to advise against its use on the face as it is likely to produce conjunctivitis. Sulphur, salicylic acid and oil of cade are also useful in psoriasis. A combination of the three, as in the following prescription, is often effective.

℞
Sulphuris praecipitati
Olei cadini
Acidi salicylici ....āā ʒ ss
Petrolati .... ℥ i
M.

For the face and scalp the following ointment is useful in many instances.

℞
Hydrargyri ammoniati ....ʒ ss
Petrolati .... ℥ i
M.

Daily warm baths should be prescribed to assist in removing the scales.

By these various measures the lesions of psoriasis often disappear, but unfortunately there is no assurance of permanent cure, for relapses are the rule rather than the exception.

Eczema and Dermatitis

Eczema is an exudative inflammatory disease of the skin characterized by redness, papules, vesicles or pustules, followed by oozing, crusting or scaling. Eczema may be acute or chronic. It has been subdivided by numerous authors into innumerable varieties. The two main theories as to its cause are diametrically opposed: The French School believes eczema to be of internal origin, while the German School (the theory of Hebra) believes it to be of external origin. The truth probably lies halfway between—*i.e.*, that some cases of eczema are of internal origin, and still others are of external origin, and still others are due to a combination of the two. If we accept the latter idea we include dermatitis in the term eczema, or *vice versa*, so that the two words become synonymous. According to Highman, "The chief reason for separating the two [referring to dermatitis and eczema] is the fact that in dermatitis a recognized excitant exists not invariably demonstrable in eczema." In another paragraph he states, "They [eczema and dermatitis] are however identical clinically and microscopically." In his classification, therefore, he considers eczema and dermatitis as one and the same disease. He prefers the word dermatitis, and divides the disease into dermatitis from external causes and dermatitis from internal causes. This point of view certainly makes the subject seem more understandable to most of us.

The most constant symptom of eczema is itching. There may also be a burning sensation. There may be oozing from ruptured vesicles, crusts formed by the drying of serous or purulent exudate, or there may be scales formed of desquamating epithelium. After continued scratching infiltration occurs, and the skin becomes leathery both to sight and to touch. Eczema may affect the skin in any or every part of the body. Its course varies greatly, depending largely on its cause. Cases originating from external irritants usually clear up when the cause is removed, but a sensitization often follows that

may preclude further handling of the causative irritant with impunity.

Occupational dermatitis, or professional eczema, is commonly confined to the hands, and is often seen in factory workers, nurses, doctors, and dentists. Lane (6) has recently described a dermatitis in dentists caused by solutions of novocain coming in contact with the skin. Indeed, in many trades dermatitis of the hands is apt to occur. Physical conditions at the place of employment may increase the susceptibility to dermatitis. The writer recalls the case of a cement worker who had been engaged at his trade for fifteen years without skin trouble, when he was put to work cementing the walls of an elevator well. His work was begun at the bottom of the well, 30 feet below the surface level. It was winter, the building under construction was unheated, and the air in the well was cold and damp. The second day at this work he acquired a severe dermatitis which kept him from work for many months. Excessive sweating also often makes the skin more sensitive to irritants; for example, when the skin is sweating freely, poisoning by poison ivy (*rhus toxicodendron*) is much more likely to occur.

In the treatment of dermatitis, any probable cause should, if possible, be removed. If the disease is acute, moist dressings may be employed, such as boric acid solutions, or drying, soothing washes, such as the following:

℞
Acidi carbolici .... ʒ ss
Zinci oxidi .... ℥ ss
Liquor calcis ....ad ℥ viii

or pastes, such as that of Lassar:

℞
Zinci oxidi .... ʒ ss
Amyli maidis
Petrolati ....āā ℥ ss
M.

may be employed. The best rule is to use only the mildest remedies in acute cases. In chronic scaling cases without much redness, and especially where there is much thickening of the horny layer, stronger applications may be used such as oil of cade, sulphur, salicylic acid, resorcin, and even chrysarobin. It is always best, however, to work up gradually to the stronger mixtures. In chronic cases ultraviolet light and X-rays are often of great value.

Ulcers of the Leg

Leg ulcers are common in all surgical clinics. The so-called "varicose ulcer" is the most common variety but the possibility of other causes than varicose veins should always be borne in mind, for ulcers of the leg due to late syphilis are not uncommon and may occur in association with varicosities. As a rule syphilitic ulcers occur higher up the leg than varicose ulcers. Furthermore, ulcers due to late syphilis have a punched out appearance and a history of rather more rapid necrosis than is usual in the varicose variety.

The immediate cause of varicose ulcers is usually trauma. The trauma may be very slight; a scratched mosquito bite may be the starting point of a large chronic ulcer. Spontaneous or traumatic rupture of a varicose vein is not an infrequent beginning of a leg ulcer. The chronicity of leg ulcers is usually due to faulty circulation which, in turn, is generally due to dilated veins and edema. In growing children without varicosities we sometimes find the hands, feet and legs blue and cold to the touch. In these children ulcers of the leg are apt to result from slight trauma, which are sometimes as obstinate as an old chronic varicose ulcer.

Here, too, it is sluggish circulation which makes healing difficult, for although varicosities may be absent the functional vasomotor disorder leading to poor peripheral circulation may lead to obstinate leg ulcers.

Leg ulcers cannot all be treated alike with success, and much judgment is, therefore, often required in the choice of treatment. Some persons are benefited by the application of a 5 per cent. Scharlach R ointment, while others with sensitive skins or a tendency to eczema will be made worse by it. If the patient is able and willing to go to bed or give up work and keep the leg up most of the time, it is often advisable for him to do so, as healing will almost always be hastened; on the other hand, if a leg ulcer can be healed with the patient on his feet, it is more likely to stay healed.

To put the ulcer in the best condition for healing, the ulcer itself should be kept clean, edema of the leg should be combatted by bandaging or by keeping the leg raised, or both, the circulation should be promoted, and epithelial growth should be stimulated. Many methods are in use for keeping the ulcer clean. Here, also, it is difficult to generalize for while peroxide may do well in some cases, it may prove irritating in others. The same is true of boric acid solutions. If Dakin's solution is used, the skin should be carefully protected; otherwise much irritation is likely to occur. Boric acid ointments, black wash, Balsam of Peru in oil or ointment, Scharlach R in ointment, and Lassar's paste may all at times be used to advantage. Whatever method of treatment is used, bandages or elastic stockings should be worn whenever the patient is on his feet.

In recent years sunlight treatment for ulcers has been used with much benefit. Its good effects are probably due to stimulation of the local circulation by the solar rays. If natural sunlight is to produce the best results, the ulcer must be exposed to the sun many hours a day. To save much time or to take the place of sunlight ultraviolet light may be used. It is extraordinary how quickly many foul, dirty ulcers may be converted into red, healthy granulations by the use of ultraviolet light. A few minutes' exposure of the ulcer and surrounding skin gives rise to a "sunburn," which appears the next day. This sunburn means active hyperemia, in other words, an increased flow of arterial blood to the skin about the ulcer, and it must be granted that such a condition combats infection and stimulates epithelial growth.

It is occasionally advisable to skin graft ulcers of the leg. In such cases a few exposures of the ulcer to ultraviolet light will often prove of the greatest help in preparing the field for the operation. Foote (7) states that "The leg of an unhealthy or aged person is a most unfavorable site for skin grafting. Sometimes the grafts will not attach themselves, sometimes they atrophy for lack of nutriment while the patient is still in bed." These statements are undoubtedly true, but if the area to be grafted were given three or four exposures to ultraviolet light in proper dosage, the writer feels sure that failures in skin grafting would be far less frequent even in the aged or debilitated.

After a leg ulcer is healed, the question of the advisability of an operation for varicose veins arises. Much good may be accomplished by operation in suitable cases, but the selection of these cases requires a considerable amount of experience and judgment. If the valves of the internal veins are incompetent the

best results cannot be looked for from an operation. If an operation is not advisable the patient should be instructed to wear an elastic stocking or leg bandage constantly during the day and never to be on his feet without such support.

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EXPERIMENTAL OBSERVATIONS UPON THE RELATION BETWEEN ATMOSPHERIC CONDITIONS AND THE PRODUCTION OF FATIGUE IN MINE LABORERS*

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Introductory

It has long been known that oppressive atmospheric conditions have a prejudicial effect on the output of work and the health of the workers subjected to such conditions, but until comparatively recently there has been a decided lack of definite information with regard to the casual factors in good or bad air conditions, and consequently a lack of adequate standards of good conditions.

Dr. Leonard Hill, the eminent physiologist, as a result of his classical researches, has disproved the validity of many of the accepted ideas and established new standards of ventilation. Several years ago, some of the results of Dr. Hill's researches were brought to the notice of one of us (A.J.O.), who procured the necessary instruments and had a series of readings taken in various parts of the Rand Mines, to determine how the conditions there compared with ideal conditions and also, to some extent, how these conditions affected the workers physiologically. Readings of the cooling power of the air were taken by the kata-thermometer (an instrument designed and introduced by Dr. Hill), and of the temperature by wet and dry bulb thermometer; also skin temperature and loss of weight of the workers were recorded, and general observations were made as to the effect produced by the conditions in the various parts of the mines.

These investigations furnished a great deal of useful information but it was felt that it was of the utmost importance to make further investigations, particularly with regard to the effects of atmospheric conditions on "output of work" and on the fatigue produced in the workers. In 1919 the second subscribed (H. J. I.), Testing and Investigating Engineer of H.M. Office of Works, London, who had had considerable experience in ventilation problems and had made some study of fatigue and other physiological effects of atmospheric conditions, was out in this country on work for the Union Government, and it was considered that if his services could be obtained for the investigation proposed it would be a good opportunity to have it carried out. The proposal was made to the Chamber of Mines and agreed to, and a committee was elected to advise on and control the investigation. Mr.

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P. Hendry was selected from the Engineering Department, Central Mining & Investment Corporation, Ltd., to collaborate in the work, which was begun on January 1, 1920.

The aspects of the problem intended to be investigated were as follows:

1. Influence on fatigue of atmospheric conditions.
2. Influence on fatigue of short rest periods.
3. Influence of midday meal.
4. Influence of posture on fatigue.

Also, if time permitted,

5. Relation of dust content to fatigue.
6. Relation of CO_2 content to fatigue.
7. Hospital records of selected classes of workers in various occupations and under various conditions of work (if possible).

It was thought that after apparatus had been designed and obtained, six months would be ample time to carry out tests, which, though by no means exhaustive, would furnish sufficient information to enable estimates to be made with regard to loss of output due to bad conditions, and with regard to the effect of poor working conditions on the health of the workers.

The investigation was fraught with difficulties, since the investigation of fatigue is, with the best conditions, a somewhat difficult matter. Up to the present time, fatigue tests have been chiefly carried out in the laboratory on intelligent subjects; whereas, in this case, the subjects were natives and the apparatus had to be capable of withstanding the rough conditions of the mines, and of registering, as nearly as possible, normal mining work.

A good deal of preliminary experimenting was required before satisfactory apparatus was decided on, and a much longer time than was anticipated was occupied in constructing the apparatus. Shortly after the tests were begun, Mr. Hendry was recalled to the Engineering Department to take up an important post, and a man entirely new to the work (Mr. R. Huntley-Smith, B.Sc., F.G.S.) had to be instructed in the principles of the investigation and the use of the apparatus. A great many unforeseen difficulties arose during the tests, such as accidents to apparatus, which occasioned the loss of valuable time, with the result that only part of what the investigators set out to do has been accomplished, and has occupied a much longer time than was anticipated. The tests have, however, afforded much useful and interesting information, and it is hoped that they will provide a basis for estimates of efficiency and a guide to the working conditions to be aimed at. More particularly it is hoped that the results achieved will be accepted as warranting further, more inclusive and more detailed research on similar lines.

Besides giving the facts established by the investigation, the investigators have included in this report some of the results of other investigations, such as those on the general questions of fatigue and ventilation, and have also included possible facts indicated, though not actually demonstrated, by the tests; otherwise the report would lose much of its significance.*

* The investigators are much indebted to Mr. J. Whitehouse, Manager of the Village Deep Mine, for permission to carry out the tests in that mine, for lending the native subjects, and for providing the necessary facilities for the tests, and to various members of his staff for their kind assistance in constructing and repairing parts of apparatus, etc.; to Professor J. Orr of the Engineering Department of the University, for allowing the use of his workshop and machine tools for the construction and testing of some of the apparatus; to Messrs. Reunert & Lenz for the loan of a fan with water-motor; to Mr. P. Hendry, B. Sc., Chief Draughtsman, Central Mining, for his help in the design, construction and adjusting of the apparatus in general, and especially for his work in connection with the hammer ergometer with regard to which we consider it justifiable to lay claim to originality of design and adaptation; to Mr. A. Gordon, Chief Sanitary Inspector, Rand Mines,

To enable those, who have not studied the problems of fatigue and the physiological aspects of ventilation, to appreciate the results of the investigation, it will be better at this stage to discuss briefly the fundamental principles of these subjects.

General Principles of Fatigue

When a muscle or group of muscles, such as the flexor muscles of the forearm or fingers, are repeatedly contracted against sufficient resistance with certain rapidity, there soon comes a time when not only has the amplitude of motion been considerably diminished, but any further movement whatever becomes impossible; that group of muscles has been "fatigued to exhaustion" and will take considerable time to recover. This process takes place whether the muscular contraction is actuated by the will or is stimulated by the repeated application of an electric current to the nerves controlling the group of muscles.

Many investigators have contributed to the sum of knowledge on fatigue, but the one who stands out pre-eminently as having done most to investigate human fatigue is Professor Mosso of Turin University, whose researches, with those of his followers, have shed a flood of light on this complex problem and have established most of its fundamental laws. His work has been supplemented by others, chiefly with regard to the biochemic processes, and in recent years by many investigators in the field of industrial fatigue.

Muscular activity is a biochemic process, a form of combustion, in which the energy-giving material, called glycogen, is oxidized in the muscles, forming sarcolactic acid and carbon dioxide. The glycogen is a form of sugar derived from the dextrose of the blood and elaborated by and stored in the muscles. The liver also has the faculty of secreting and storing considerable amounts of glycogen which can be used as an emergency store when the muscle supply is exhausted. The sarcolactic acid formed during muscular action, and probably other chemical products, have a toxic effect on the controlling nerve endings, thus inhibiting further action. The process of fatigue, then, is twofold: (1) the consumption of the energizing material; and (2) the production of waste products and toxins paralyzing the nerve control.

So far, we have very briefly dealt with local fatigue, the process of recovery from which is the renewal from the blood stream of the glycogen in the muscle, and the washing away by the blood stream of the toxic and waste products. As muscular action proceeds, the blood stream, as it washes away the toxic products, becomes less and less capable of absorbing more, until finally there results a condition of general fatigue in which every muscle of the body is affected. This principle was made use of by Mosso to estimate general fatigue by the ergograph. If fatigue products are produced at such an extreme rate that the blood becomes surcharged, death may ensue, and instances are known of runners and hunted animals dropping dead through sheer excess of fatigue toxins in the blood, inhibiting the action of the muscles of the heart, and thus causing death.

Ltd., for valuable help in preparation of illustrations, diagrams, etc., in the taking of general kata-thermometer readings, and for useful information and suggestions gained in his experience of previous tests of atmospheric conditions in several of the Rand Mines; and lastly, but not least, to Professor Leonard Hill, F.R.S., who has freely given information and literature on the physiological aspects of the problem, whose researches form the basis of this investigation, and whose instrument, the kata-thermometer, has made possible the exact measurement of atmospheric conditions.

In the use of the ergograph a small group of muscles, let us say, for example, those flexing the middle finger, are made to contract, lifting a weight or extending a spring, the other fingers and the wrist being fixed to confine the movement to the one finger; the contractions proceed at a predetermined rate until no further movement is possible, a record of the movements being traced on a smoked cylinder or roll of paper. The curve joining the upper limits of a fatigue tracing may be called the "curve of fatigue," and the degree of general fatigue at any time may be estimated by comparing the records taken when the body is fresh, and after work is performed. The amount of general fatigue produced in taking the ergograph record is usually so small as to be negligible.

The recovery from a condition of general fatigue is a process requiring several hours of rest and sleep, during which mental consciousness and the greater part of the muscular activity of the body are suspended, respiration and the heart's action are slower, and the vital energy of the body controlled, perhaps, by the subconscious mind, is directed to the elimination of waste products from the tissues to the blood stream and from there to the organs of excretion, to the rebuilding of wasted tissue and the re-storage of energy-giving constituents. If the period of rest and sleep is adequate, the production of fatigue products is balanced by the elimination, and the body is capable of starting afresh to perform good work; but if not, the results of fatigue are partly carried over to the next day, and if work is repeatedly followed by inadequate rest and recovery, an accumulation of fatigue products is produced in the body, the tissues and muscles are never properly cleansed, the individual becomes chronically tired and inefficient and will ultimately show definite pathological symptoms.

In some instances fatigue seems to be greatest in the morning after rest and to diminish as the day goes on. This occurs in the healthy person when there has been especially heavy and prolonged exertion on the previous day. It may, in some cases, be due to interrupted rest, the process of elimination of waste products being interrupted when in full swing. In certain instances it may be due to the accumulation of bacterial or other toxins interfering with the normal process of elimination and leaving a residuum of waste products always in the tissues or blood stream. These conditions, however, are neither normal nor ordinarily met with, but mention is made of them as they seem to occur in a few instances in the tests.

The results of over-fatigue are well known. Some of these are: lassitude, loss of mental alertness, craving for stimulants, decreased resistance to disease, increased liability to "chill," nervous irritability and discontent, and, as shown later, an enormous lowering of efficiency in the performance of work. A great deal of the labor unrest as well as the high morbidity in munition workers in England during the first years of the war was attributed by those who investigated the matter to cumulative fatigue consequent on long hours of strain and labor, overtime, night work and Sunday work, the rest period being decidedly inadequate (1). Greater output was effected when these defects were remedied.

One of the most important facts established by fatigue tests is that, after fatigue has set in, physical efficiency falls off enormously, or, in other words, the physical and nervous energy expended in performing a certain amount

of work is enormously increased. This applies both to local and general fatigue. After general fatigue is well advanced, work of any kind is carried on at a ruinous expenditure of energy, sapping the sources of vital energy and using up reserve forces.

There are three classes of fatigue with which we have to deal: (1) where a group of muscles is rapidly fatigued to exhaustion in a few minutes; (2) where a certain degree of fatigue is produced both locally in the muscles and generally in the body after several hours of work; and (3) where muscular action is such that the rate of fatigue production is balanced by the rate of recovery, and muscular activity could be continued indefinitely but for the ultimate production of general fatigue. The first class is very rarely met with in industrial conditions, but occurs, of course, in ergograph tests. General industrial conditions usually fall into classes (2) and (3), and the problem is to arrange hours and conditions of labor so as to get the best efficiency from the worker —that is, to get the greatest output with the minimum of fatigue.

There are many contributory factors in fatigue, some of which play a very important part. Special mention should be made of the influence of excessive heat, which accelerates considerably both local and general fatigue. If the arm is immersed in water of a temperature several degrees above that of the body, fatigue of the muscles is more quickly produced than in normal conditions. This is due, for the most part, to the diversion of the blood stream to the cutaneous vessels, the muscles being left with insufficient means of nourishment and of being cleansed from waste products. It may also be due to the direct effect of heat on the chemical processes. A similar effect is produced by heat on the body generally—a subject which will be dealt with more fully when the physiological effects of excessive heat are considered. Other contributory factors in fatigue are: mental influences, such as fear and worry—which seem to have a decidedly prejudicial effect on the elimination of toxins—also lack of interest and pleasure in one's work; presence of bacterial and other toxins due to errors in diet, constipation, disease, etc.; deficiency of essential food elements, such as, for instance, the organic salts and vitamines. In short, anything which impairs the general health will make the production of fatigue more easy.

We have not dealt with the problem of "nervous fatigue" as this does not arise to any great extent in connection with native labor on the mines; but though the processes are, no doubt, different from those of physical fatigue, the same general laws apply to a great extent.

Some interesting experiments were conducted during the war on the effects of small quantities of alcohol on fatigue and output of munition workers. The conclusions arrived at indicated that the output was not appreciably affected either way (2.)

Output of Work

In producing a given amount of fatigue a number of factors may be involved, which will have varying effects upon the output of work. Or, conversely, for a given amount of work done, these factors will influence the degree of fatigue produced. Proper technic or elimination of waste motion may raise physical efficiency enormously. This is very marked in such work as that of using a hammer and jumper in drilling holes in the rock.

The medical officer of one of the large National Shell Filling Factories in England told one of us (H. J. I.) that he observed that in the process of "hand-stemming" shells with amatol—an operation performed with a wooden stemmer or ram and mallet—men who had been accustomed to the use of a mallet and chisel, such as stonemasons, got through much more work with less fatigue than others without previous training.

Proper and comfortable position of the body is another factor in output, as the body in an awkward position is kept constantly at work contracting unnecessary muscles, thus producing more fatigue and also spoiling the exactitude and effectiveness of the working movements.

A very important factor in performing work is what may be called "optimum effort and speed." To illustrate this, let us consider the performance of 1,000 foot-pounds of work per minute (1) by raising 200 pounds a distance of 6 inches, 10 times per minute, or (2) 20 pounds 2 feet, 25 times per minute, or (3) 2 pounds 2½ feet, 200 times per minute. Though the rate of doing work is the same in each case, methods (1) and (3) will tire a man much more quickly than method (2)—(1) by excessive effort, (3) by excessive speed. Between these extremes there will be an "optimum effort and speed" somewhere about that given in (2). This factor is taken into account in the design and use of one of the ergometers. Another everyday illustration of this principle is the gain of human efficiency in the use of variable speed gear over single gear in a bicycle.

Physiological Aspects of Ventilation

As mentioned in the introduction, it is only within recent years that physiologists have given to us definite information regarding the factors in healthy atmospheric conditions. Dr. J. S. Haldane, of Oxford, has done an immense amount of brilliant pioneer work in connection with the physiology of respiration. His investigations into atmospheric conditions in mines and elsewhere, his careful recording and classification of the physiological phenomena connected therewith, the results of his painstaking investigations of the effects of such poisons as carbon monoxide and by-products of explosives, and of the effects of various kinds of dust, the attention which he has called to the importance of humidity and wet-bulb temperatures, etc., have given information of inestimable value to the mining industry.

Dr. Leonard Hill, F.R.S., has approached the subject of atmospheric conditions from a somewhat different standpoint. He has given more attention to the physical, as well as the physiological, aspects of the atmospheric conditions met with in everyday life, to the probing to the root such causal factors as those which make air "bracing" or otherwise, to the establishing of definite quantitative values to these factors, to the setting on foot a propaganda controverting misconceptions and wrong standards held by ventilating engineers, and to the inventing and designing of an instrument—the kata-thermometer—to enable ventilating engineers to determine atmospheric conditions with ease and with a fair degree of exactitude.

The term "fresh air" has long been associated with chemical purity, sufficiency of oxygen, and freedom from respired products, such as excess of carbon dioxide, and supposed organic toxins. Ventilation rules and government regulations are still commonly

based on this conception or, rather, misconception. For example, the carbon dioxide content of outside air varies between, let us say, 3.5 and 4.5 parts in 10,000, and some ventilation rules state that the supply of fresh air to a building should be such as to keep the carbon dioxide content of the inside air not more than 5 parts in 10,000 in excess of that of outside air; the government regulation, that the carbon dioxide content of air in the gold mines must not exceed 0.2 per cent., seems to be based on the idea that carbon dioxide exceeding this amount is either a poison in itself or an indication of the presence of other poisons. Dr. Hill has shown that these conceptions of "freshness" are quite fallacious. With his collaborators, Dr. Martin Flack and the late O. W. Griffith, he has collected, confirmed by experiment, and synthesized many of the results of previous research; moreover, he has extended these researches considerably along lines of his own, particularly with regard to the effect of open air, exercise and rest on the respiratory metabolism.

In one class of his experiments Dr. Hill had seven or eight students shut in an air-tight chamber of about 3 cubic meters' capacity, which was provided with a large observation window, with electric fans for putting the air in motion, and with means of varying the temperature and humidity of the air. On one occasion the students were confined there till the carbon dioxide content had reached from 3 to 4 per cent., and the oxygen content had fallen from the normal (about 20 per cent.) to 16 or 17 per cent., the air failing to support the combustion of matches which the students struck in vain attempts to light cigarettes. The wet bulb had risen to about 83° F., and the dry bulb was slightly higher. The discomfort of the students was considerable, their faces flushed, their pulse rate high, and their skin and clothes moist with sweat. *The starting of the fans gave immediate relief* and lowered the average pulse rate from 97 to 79 per minute, though no fresh air from outside was admitted, the fans merely setting in motion the air in the chamber. When the fans were stopped, the students begged to have them started again. *Breathing fresh air from outside through tubes gave no appreciable relief, and persons outside breathing the vitiated air of the chamber experienced no discomfort.* The sudden introduction, from a bag, of carbon dioxide up to 2 per cent. was not discerned by the inmates of the chamber.

In another class of experiments, guinea-pigs were confined for several weeks in a box through which the exhaled air of rats was passed. They were afterwards inoculated with blood serum from the rats but showed no signs of anaphylactic shock, thus demonstrating that breathing the exhaled air of rats had not sensitized them to rat serum. The guinea-pigs, which were again inoculated after the lapse of another three weeks or so, rolled over and died, showing that the first inoculation had sensitized them. Dr. Hill rightly reasons from this that there cannot be any toxins of a protein nature in exhaled air.

After the introduction of the katathermometer to measure the cooling power of the air, many interesting experiments were carried out on the respiratory metabolism, or the interchange of oxygen and carbon dioxide, in atmospheres of different cooling power, and under varying conditions of rest and exercise. The subjects of the tests breathed through the mouth into light bags arranged with valves, clips being fastened over the nostrils to prevent nasal breathing. The air in the bags

was afterwards measured by a gas-meter and analyzed for oxygen and carbon dioxide.

The results of Dr. Hill's researches may be summarized as follows:

1. That the quality of "freshness" of air is due to its cooling power on the body, and that, on the contrary, oppressiveness of ordinary atmospheres is due, not to deficiency of oxygen or excess of carbon dioxide and organic toxins, but to "heat stagnation."
2. Cooling power depends on temperature, humidity, and motion of the air, and is increased by low temperature, low humidity and high velocity of motion.
3. That carbon dioxide content up to 1 per cent., or even higher, produces no deleterious effects or stresses on the human system, the only effects being slightly greater ventilation of the lungs such as would take place with moderate increase of exercise.
4. That there is no evidence of the presence of organic toxins in exhaled air.
5. That cooling power in the air—unless carried to extreme—has a beneficial effect upon health generally. It promotes the metabolism of the system, assists elimination of toxins and waste products, and increases immunity to infectious and other diseases.

In considering the effect of carbon dioxide, it is pointed out that the alveolar air, or air in the lung sacs, at ordinary pressures contains from 5 to 6 per cent. of carbon dioxide, at about which value it is kept involuntarily by the nerves controlling respiration; when the carbon dioxide tends to exceed this value, greater ventilation of the lungs is induced.

The only result of breathing 0.5 per cent. of carbon dioxide is a slight and unnoticeable increase in the ventilation of the lungs. Two per cent. carbon dioxide increases pulmonary ventilation 50 per cent.; 3 per cent., about 100 per cent.; and 5 per cent., about 300 per cent. (3). Normally we never empty the lungs, and the residual air and that in the respiratory passages, which contains over 3 per cent. carbon dioxide, is continually rebreathed. Workers in breweries and aërated-water works, where the carbon dioxide content may be from 1.5 to 2.5 per cent., suffer no deleterious effects. In submarines, the crew can tolerate carbon dioxide in the atmosphere up to 3 per cent.

In dealing with fatigue it was mentioned that muscular activity was accompanied by the oxidation of glycogen; this is a chemical process producing heat, a process continually going on to a greater or lesser degree while life lasts. This heat production varies with the degree of muscular activity, and is least when the body is recumbent, relaxed and asleep. This heat-producing activity when the body is resting, Dr. Hill calls the "basal or minimal metabolism," and, as will be seen later, its amount is an important factor in a man's capability to perform work in a hot atmosphere. Heat production is considerably increased when external work is done. The basal metabolism of the average man corresponds to a heat loss of about 1 millicalorie per square centimeter of body surface per second; work may bring it up to 3 millicalories (3).

The heat generated by muscular activity must be dissipated in some way or other, otherwise the temperature of the body will rise and cause serious disturbances. The heat is dissipated from the body surface by (1) *radiation*, (2) *convection*, (3) *evaporation*. The cooling due to (1) depends on the temperature of surrounding objects; to (2), on the temperature and motion of the surrounding air; and to (3), on the vapor tension and movement of the surrounding air.

The body has a very sensitive heat regulating mechanism; when the body temperature tends to rise, the cutaneous blood vessels are dilated by nervous action, and the blood is therefore di-

verted to these vessels, raising the skin temperature and increasing heat loss by radiation and convection. If this is not sufficient to balance heat production, the sweat glands are actuated and heat loss considerably increased by the evaporation of moisture—provided, of course, that in the first place the air temperature, and in the second place the wet-bulb temperature, is lower than that of the body surface. The body will make strenuous efforts to prevent a rise in its temperature, and these efforts will be very successful if it be physically possible.

A considerable amount of heat is also lost by evaporation from the respiratory tract, the amount varying with the volume of air respired and the dryness of the air. Except when the inhaled air is very cold, the temperature of the exhaled air will be approximately 35° C. (95° F.), with a relative humidity near the saturation point. The amount of moisture evaporated per unit volume will be the difference between the moisture contained in nearly saturated air at 35° C. and the actual moisture content of the inhaled air.

TABLE 1.—AMOUNT OF MOISTURE EVAPORATED FROM RESPIRATORY TRACT FOR EVERY 100 CUBIC FEET OF AIR EXHALED, WITH VARIOUS CONDITIONS OF INHALED AIR

Temperature	Relative Humidity	Water Evaporated	Remarks
F.	%	*lbs.*	
84	10	0.227	Rand—dry spring day
45	20	0.236	Rand—dry winter day
60	50	0.204	Rand—annual average conditions
65	90	0.158	Mine—good place
87	95	0.063	Mine—bad place

Table 1 shows the evaporation from the respiratory tract for every 100 cubic feet of air exhaled, with various conditions of inhaled air. The volume of air inhaled by a man when working is about 60 cubic feet per hour, and when resting, about 20 cubic feet.

According to Leonard Hill, a considerable evaporation from the respiratory tract produces a copious flow of fluids from the lymphatic glands to the mucous membrane, and also stimulates increased blood flow to make up the heat loss, both of which processes promote immunity from bacterial invasion. Whatever the process is, the results are undoubtedly borne out by practical experience; high altitudes, where the air is dry and where the volume inhaled is increased owing to its lesser density, have a beneficial effect in preventing and curing respiratory diseases.

In order that the body may dispose of its heat without strain, the cooling power of the surrounding air should be adequate. Dr. Leonard Hill has recommended the following cooling powers for persons doing different classes of work, the units being in millicalories per square centimeter per second:

1. For sedentary workers, 6 by dry "kata," 18 by wet.
2. For light manual work, 8 and 25.
3. For heavy manual work, 10 and 30.

These figures are based principally on dry "kata" cooling powers necessary to prevent pronounced sweating and feeling of oppressiveness, the wet "kata" cooling powers being those values which would generally correspond to the values of dry cooling power, in climates similar to that of England. On the Rand the wet "kata" values will be considerably higher on the surface, and considerably lower in the mines where the humidity is high, for the same values of dry cooling power. The figures, moreover, apply to persons wearing ordinary

clothing. Clothing makes a considerable difference, the cooling power on the body with ordinary outdoor spring clothing being about 50 to 60 per cent. of that of the naked body. The native stripped to the waist while working in hot conditions underground gives himself a great advantage over the clothed white man.

For the purpose of the mines the wet kata-thermometer may be taken as the best standard of comfort, as it includes all the factors in cooling power on the body—temperature, humidity, and motion. Dr. Haldane, as a result of investigations into the effects of hot and humid atmospheres, recommends the wet-bulb temperature as the standard of comfort; but the latter does not take into account the important factor of *motion* of the air, and is a just standard for still air only.

In Table 2 are given values of cooling power by wet kata-thermometer, with the corresponding physiological effects which are likely to be produced. The cooling powers of dry "kata" are the corresponding values which will probably occur in underground conditions. (These are based on numerous observations in the mines of the Witwatersrand.) When the dry cooling power exceeds 8 to 10, sweating ceases, and the dry cooling power should then be taken as the standard of cooling, if the skin and clothes are dry. When the skin is flushed and moist and the clothes are wet, and wet cooling powers are above 25 units, there is great danger of producing chill unless hard work is being done and thermogenesis thereby maintained.

TABLE 2.—VALUES OF COOLING POWER BY WET AND DRY KATA-THERMOMETER, WITH CORRESPONDING PHYSIOLOGICAL EFFECTS

Cooling Power		Physiological Effects on Man Stripped to Waist
Wet "Kata"	Dry "Kata"	
5	1.5	Extremely oppressive; profuse sweating; rise of body temperature and pulse rate, especially when work is performed. Very small evaporation from respiratory tract.
10	3.5	Distinctly oppressive; body temperature can be kept nearly normal only by profuse sweating. Skin flushed and wet. Pulse rate high.
15	5.5	Lower limit for comfort.
20	8.0	Quite comfortable for work.
25	10.0	Cool and refreshing for work; too cold for resting, especially after being heated

The effect of atmospheres of low cooling power on the human system is to divert the blood circulation from its normal course through the brain and the viscera, and to some extent from the muscles, to the cutaneous blood vessels in a strenuous attempt to get rid of heat. The blood pressure falls, owing to the dilation of these blood vessels, but the pulse rate is greatly accelerated and the work of the heart thereby increased. If carried to extremes, dizziness is caused, and digestion and other vital processes are temporarily inhibited, if not entirely suspended.

The diversion of the blood stream from the muscles leaves them with impaired nourishment and reduced means of washing away waste products, and consequently muscular fatigue is greatly accelerated; moreover, the feeling of oppression, the increase of internal work, and the lack of blood flow in the eliminative organs greatly conduce to general fatigue, as distinct from muscular fatigue. These factors explain the common complaints, "no appetite for food," "no energy," etc., from men working in hot, oppressive atmospheres underground.

R. R. Sayers and D. Harrington,

Chief Surgeon and a Mining Engineer, respectively, of the U. S. Bureau of Mines, carried out some investigations into the physiological effects of high temperatures and humidities in metal mines (4). In a summary of their conclusions, they state that in still air with a wet-bulb temperature over 90° F. and with a relative humidity of 89 per cent., the following symptoms were found even when little or no exercise was taken:

1. Blood pressure fell rapidly.
2. Body temperature rose; and in one case reached 102° F. after less than two hours in the hot, humid air.
3. Pulse rate increased and seemed more sensitive to exercise than normally.
4. Perspiration was very profuse.
5. Dizziness was a common symptom and sometimes was marked.
6. Physical weakness or exhaustion was marked in some cases and was present in all.
7. Inability to think quickly or act accurately was a very common symptom.
8. Nausea was occasionally produced.
9. Headache occurred occasionally.
10. Loss of weight was especially marked in men who had been employed under the conditions of the tests over a period of years, but occurred even after exposure for only a few days.

After being overheated in an atmosphere with a wet "kata" cooling power of, let us say, 5 units, the body surface remains flushed and moist, and the mucous membrane of the nose and throat congested, for a considerable time; the clothes are probably saturated with sweat and water spray, and the blood charged with waste products—in fact, the whole system is in a very susceptible state. It requires no stretch of imagination to realize that exposure to a cold, dry wind in winter on coming up to the surface—when the wet cooling power may easily be as high as 50 or over—is putting a tax on the defensive mechanism of the body which is liable to strain it very severely, if not to the breaking point.

It has long been a matter of controversy as to what constitutes "adequate ventilation" in mines. We can now definitely answer this question: Sufficient fresh air—with a margin of safety—must be supplied to dilute dust-laden air and poisonous gases, such as carbon monoxide, to a harmless degree, the fresh air being well distributed to all underground workings. The amount of fresh air should also have a definite relation to the amount of heat required to be carried off, including the heat conducted through the rock, the heat generated by explosives and by oxidation of decaying timber, and the heat given off from the workers, from lamps, and from machinery, such as electric haulage engines, etc., most of which are quantities which can be computed with reasonable accuracy. The temperature should be lowered to a reasonable degree compatible with the quantity of air introduced, and the movement of air to give adequate cooling power then obtained, if necessary, by local circulation.

First and foremost, it must be borne in mind that the aim must always be to obtain cooling power, provided poisonous gases have been reduced to a harmless amount. The cooling power should be ascertained by direct readings of the kata-thermometer. To describe it briefly, the kata-thermometer is an alcohol thermometer with a large cylindrical bulb about 4 cm. long and 1.7 cm. in diameter, with a stem about 20 cm. long graduated from 95° to 100° F. (See Fig. 1.) The range 95° to 100° is more or less arbitrarily chosen to give a mean temperature of 97.5° F. (or 36.5° C.), which is approximately that of the clothed body surface. A small reservoir

is provided at the top of the stem to give a margin of overheating without bursting the bulb, to give time to place the instrument in the position required, and to allow the rate of cooling to become steady before the meniscus has fallen to 100°.

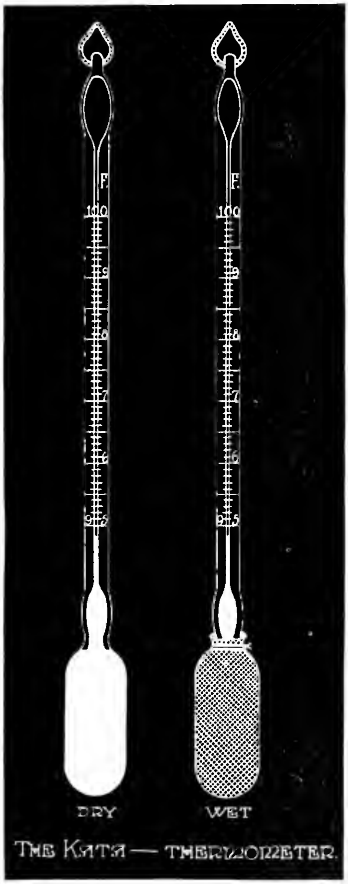

FIG. 1.—Kata-thermometer.

In taking a reading of cooling power on dry surface the bulb is used bare, and is heated in hot water (at about 80° C.) until the alcohol rises into the top reservoir and all air bubbles have been driven to the top of the meniscus. A thermos flask is very convenient for holding the water and keeping it hot during a short series of readings. The bulb and stem are then dried and the instrument suspended in the position required. The time in seconds for the meniscus to fall from 100° to 95° is taken, preferably by a stop watch. Each instrument is carefully calibrated and marked on the back of the stem with a factor, or coefficient, such that the factor divided by the time of cooling in seconds gives the cooling power in millicalories (1/1000 gram calories) per square centimeter of cooling surface per second. In other words, the factor is the time of cooling in seconds necessary to give a cooling power of 1 millicalorie per square centimeter per second. In all instances when figures of cooling power are given it should be understood that they refer to millicalories per square centimeter per second.

The wet cooling power is taken in a similar manner to the dry. The thin lisle thread finger stall supplied with the instrument is drawn over the bulb which is heated in hot water. The surplus water is then shaken off, the instrument exposed in the required position, and the time of cooling taken. Where the cooling power varies owing, for example, to fluctuating draughts, several readings of each kind, perhaps five, should be made and the averages taken as the true values.

To determine the laws governing the relations between cooling power and the separate factors of temperature, humidity, velocity and density of air, a series of experiments were carried out by Hill and his collaborators, in which wet and dry "kata" readings were taken with variation of these factors. The following relations were established:

Let Hd = cooling power by dry "kata."
Hw = cooling power by wet "kata."
t = temperature of air in degrees centigrade.
ϕ = excess of "kata" temperature over temperature of air = 36.5° − t.
V = velocity of air movement in meters per second.
F = vapor tension in millimeters of mercury at 36.5° C. = 45.6 mm.
f = vapor tension of the air.

Dry "Kata" Formulae:

In still air, $Hd = 0.27\,\phi$ (1)

In wind with velocity less than 1 meter per second,

$$Hd = (0.2 + 0.4\sqrt{V})\phi \qquad (2)$$

In wind with velocity greater than 1 meter per second,

$$Hd = (0.13 + 0.47\sqrt{V})\phi \qquad (2a)$$

Wet "Kata" Formulae:

In still air, $Hw = Hd + 0.085\,(F - f)^{4/3}$ (3)

In wind with velocity less than 1 meter per second.

$$Hw = Hd + (0.06 + 0.073\sqrt{V})\,(F - f)^{4/3} \qquad (4)$$

In wind with velocity greater than 1 meter per second,

$$Hw = Hd + (0.035 + 0.098\sqrt{V})\,(F - f)^{4/3} \qquad (4a)$$

Formulae (2) and (4) do not hold good with velocities less than 0.04 meters per second, as this gives practically the same cooling as still air.

Considering equation (1), the cooling power is produced partly by radiation, and partly by convection currents set up by the hot bulb of the "kata," and at ordinary temperatures and pressures approximately half the heat is lost by radiation, and half by convection. The heat lost by convection will vary as the square root of the density of the air, that is, as the barometric pressure, while the heat lost by radiation will be independent of barometric pressure.

If H_1 = cooling power at pressure p_1 height h_1
H_0 = cooling power at pressure p_0 and sea level

Then $H_1 = H_0/2 + H_0/2\sqrt{p_1/p_0}$

$$\text{or } H_1 = H_0\left(\frac{1 + \sqrt{p_1/p_0}}{2}\right) \qquad (5)$$

That is, the percentage change in cooling power is approximately one-fourth of the percentage change in pressure. This formula, which is the one given by Dr. Hill, obviously applies only to still air cooling. We suggest the following as a general formula to include wind conditions, for pressures different from that at sea level:

$$H = \left(0.13 + 0.07\sqrt{\frac{p_1}{p_0}} + 0.4\sqrt{\frac{\sqrt{p_1}}{p_0}}\right)\phi \qquad (6)$$

to replace (2)

$$\text{and } H = \left(0.13 + 0.47\sqrt{\frac{\sqrt{p_1}}{p_0}}\right)\phi \qquad (6a)$$

to replace (2a)

At the altitude of the Rand these become

$$H = (0.19 + 0.36\sqrt{V})\,\phi \qquad (7)$$

$$\text{and } H = (0.13 + 0.43\sqrt{V})\,\phi \qquad (7a)$$

At the average working depths of the mines the change is negligible.

As H is proportional to Φ, the dry cooling power, say (H_2) of a hot surface at a temperature (t_2) other than 36.5° C., can be derived from cooling power H_1 at 36.5 C. by the equation

$$H_2 = H_1\,(\phi_2/\phi_1) \qquad (8)$$

where Φ difference between 36.5° and air temperature and $/\Phi_2$ is difference between $/t_2$ and air temperature. This formula is useful for taking out values of cooling power at skin temperatures which are usually lower than 36.5°.

To find the wet cooling power at a temperature ($/t_2$) other than 36.5° C., after substituting in equations (3) or (4) the new value of Hd, substitute for F the vapor pressure at temperature $/t_2$.

The equations given by Dr. Hill, which include (1) to (4), also (5) and (8), have all been tested and proved experimentally. These formulae can be used to calculate values of wet and dry

cooling power, when the temperature, vapor pressure, and velocity of the air are known, and, in the case of the outside air, from meteorological records. They can also be used to analyze katathermometer readings and to determine what part each factor is playing. This is particularly useful when one is setting out to alter conditions.

An examination of equations (2) and (4) shows how the cooling powers both by wet and dry "kata" are considerably increased by wind or air motion. The effect on the dry cooling power will perhaps be more clearly shown by the curves in Figure 2 giving the relation between values of H/Φ and air velocity. For example, assuming that the air temperature is 25.5° C. (78° F.), then $\Phi = 36.5 - 25.5 = 11$; an increase of velocity from zero to 1 meter per second (197 feet per minute) will increase the value of H/Φ from 0.27 to 0.6, or the value of H from 3 to 6.6, that is, from distinctly

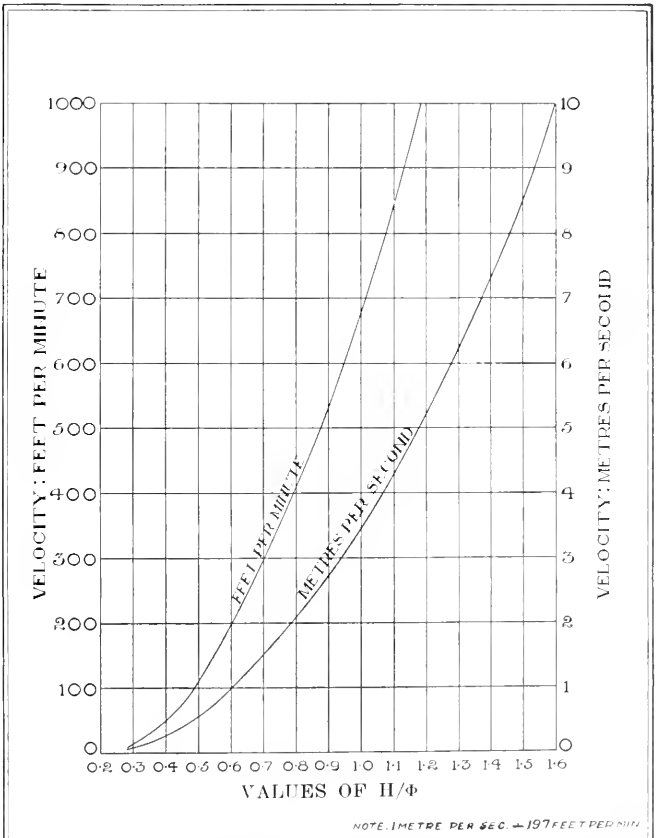

FIG. 2.—Curves showing relation between values of H/Φ and air velocity.

oppressive to refreshing conditions. To get the same increase of cooling power in still air the temperature would have to be lowered to 12.1° C. (54° F.). It is quite evident which is the easier method of obtaining the result. As a matter of fact, it is difficult to overstate the importance of air movement in obtaining good conditions.

Mr. D. Harrington, Mining Engineer of the U. S. Bureau of Mines, although he does not seem to have had the advantage of using the kata-thermometer, has by long experience and careful observation come to have a strong appreciation of the value of air movement. In a recent article (5) he states:

> In the ordinary metal mine, the velocity of air at working faces is much more important than humidity, temperature, and content of gases, except when the two latter go to extremes. For example, men have climbed 100 feet out of a stope with pure still air at 79° F. and 86 per cent. relative humidity to "cool off" in a level where the air was 3° hotter and 5 per cent. more humid than in the stope, but was moving about 150 feet per minute.

The cooling powers of the stope and level, calculated by Dr. Hill's formulae, are 2.81 and 4.84, respectively.

At the same time, it is a considerable

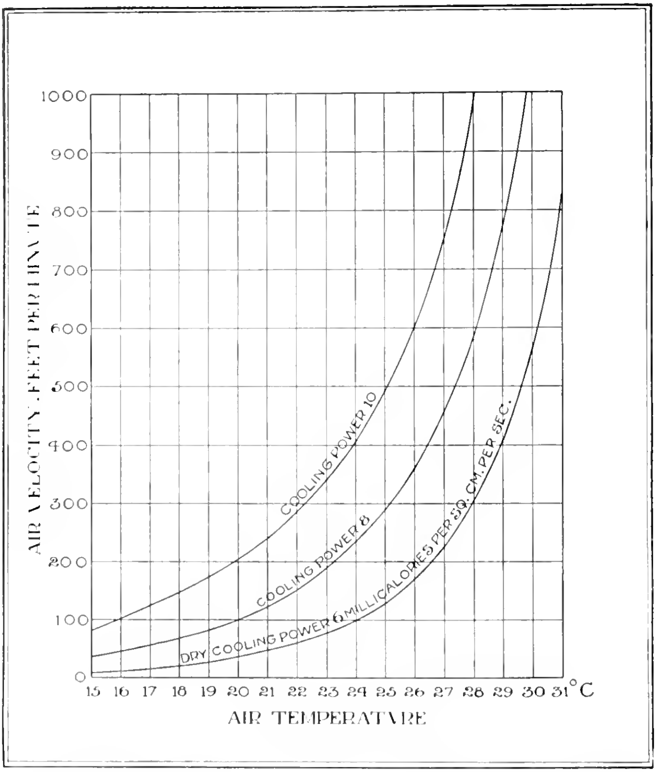

FIG. 3.—Curves showing relation between temperature and wind velocity.

advantage to have the air cooled down to 25° C. (77° F.) or lower, as this necessitates very much less air movement than, let us say, a temperature of 30° C. (86° F.). This can be done by taking in a larger amount of outside air to the mine. In Figure 3 curves are given showing the relation between temperature and wind velocity to give cooling powers of 6, 8 and 10 by dry "kata," the values given by Dr. Hill for sedentary work, light manual work, and heavy work, respectively. It will be observed how rapidly the required velocity rises as the temperature approaches 25° C. (77° F.) for cooling power 10, and 30° C. (86° F.) for cooling power 6. This illustrates the advantage of cooling the air down to, let us say, 25° C. at least, after which adequate cooling power can be obtained economically by local circulation.

It should be noted that air movement, so far as it affects cooling power, is not limited to unidirectional current but includes every eddy or swirl which helps to remove the warm, humid air from the clothes and skin. Thus air, the velocity of which cannot be determined by the anemometer, may have considerable cooling power due to eddy motion; consequently, direct readings of cooling power by the kata-thermometer are preferable to calculated values. From equations (2) and (2a), if the temperature and cooling power are known, we can calculate the velocity (or equivalent velocity) of the air. If the stream lines of the air are fairly regular, as in air flowing through long parallel passages, the kata-thermometer can be used as an anemometer in conjunction with an ordinary thermometer, the velocity being calculated in meters per second from equation (2), or taken from curves similar to those shown in Figure 2.

As the kata-thermometer measures only its own rate of cooling, its readings have either to be translated into approximate physiological effects, as given previously in Table 2, or their relation given to the actual cooling of the human body; for all practical purposes the former method is good enough, though the latter is interesting and useful for research purposes and for estimating from the metabolism how much heat is generated in the body. From observations carried out on various subjects Dr. Hill estimates that the heat dissipated from unit surface of the body of a person ordinarily clothed, in cool outside conditions when no decided sweating occurs, is from one-sixth to one-seventh of the dry "kata" reading corrected to the skin temperature of the cheek. The conditions will, of course, change immediately upon the occurrence of sweating. It does not necessarily follow that two different sets of conditions (temperature, humidity and motion) which give identical readings on the "kata" will produce identical effects on the body. The kata-thermometer readings, moreover, give no reliable indication of the evaporation from the respiratory tract, this being dependent *not* on the motion of the air, but on the amount of air breathed and its absolute moisture content, which latter can be found from wet and dry bulb readings; some allowance should, therefore, be made for this factor in extremes of dryness and humidity, such as occur on the Rand, on the surface and underground, respectively.

There is a body of opinion that, besides the factors of temperature, humidity and motion, there may be other more subtle factors, on which at present we have not sufficient information. For instance, G. Stroede (6), working on

the catalysts assisting the transference of oxygen, finds a good deal of evidence that such catalysts are to some extent inhibited by exhaled air. The stuffiness of air caused by its passing over steam radiators, though the final temperature of air inhaled may be sufficiently low and the cooling power satisfactory, is another matter which requires elucidation. There is also the question of air passing over decaying organic matter, such as rotten timber, when considerable oxidation goes on and the air feels stuffy. Whether the stuffiness in the latter case is detrimental to health, or whether, like some bad smells, such as those produced in soap works and glue works, it is objectionable but innocuous, we cannot at this stage say definitely.

Ozone in very small dilutions (let us say, 1 or 2 parts in 100,000,000) seems to have a salutary effect in warding off bacterial infection, not so much by its direct germicidal action, but by its stimulating or irritating effects on the mucous membrane, producing increased flow of blood and secretion of mucus. It is stated that, during the influenza epidemic of 1918 in London, the employees of the Underground Railways who worked in places where the air was supplied with ozone had an absentee percentage of 3 due to influenza, while those whose working places had no ozone had 10 per cent. absent (7). It would be interesting to find how far ozone would help in the mines to promote immunity from bacterial invasion of the respiratory tract.

(To be continued)

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ANNUAL MEETING OF THE NATIONAL CONFERENCE OF SOCIAL WORK

The forty-ninth annual meeting of the National Conference of Social Work will be held in Providence, Rhode Island, June 22-29. In addition to the General Session meetings the Division on Health and the Division on Industrial and Economic Problems have arranged the following interesting programs:

DIVISION III: HEALTH.

Section Meeting I.—The Plan for Federal Reorganization.

Section Meeting II.—Industrial Hygiene.

Section Meeting III.—Health Experiments and Demonstrations.

Section Meeting IV.—The Art of Living.

Section Meeting V.—Social Hygiene and Venereal Disease Control.

Division V: Industrial and Economic Problems.

Section Meeting I.—Social Standards for Industry.

Section Meeting II.—The Effect of Recent Court Decisions on Labor and Industry.

Section Meeting III.—Human Relations in the Coal Industry.

Section Meeting IV.—Employees' Participation in Management.

Section Meeting V.—Stabilizing Industry.

The hotel headquarters for the Conference will be in the Hotel Biltmore.

THE SEVENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS

Washington University Medical School, St. Louis, Mo., May 22 and 23, 1922.

PROGRAM.

Monday, May 22.

9:30 A. M. at Washington University Medical School.

Business Meeting.

12:30 P. M. at Hotel Statler.

Luncheon.

1. Comments.
Chairman, J. S. Newell, Superintendent, National Lead Co., Granite City, Ill.
2. The Physician in Industry Defined.
C. E. Ford, M.D., New York City.
3. Scientific Medicine and Surgery.
George W. Crile, M.D., Professor of Surgery, Western Reserve Medical School, Cleveland, Ohio.
4. The Value of the Public Health.
Allen J. McLaughlin, M.D., President, American Public Health Association, Washington, D. C.
5. Human Conservation in Industry by Medical Supervision.
L. G. Harney, M.D., East St. Louis, Ill.

2:30 P. M. at Washington University Medical School.

1. The Workingman's Diet.
John R. Murlin, M.D., Professor of Physiology and Director, Department of Vital Economics, University of Rochester, Rochester, N. Y.
2. Sickness Records in Prevention Work.
Edgar Sydenstricker, U. S. Public Health Service, Washington, D. C.
3. Mercantile Hygiene.
Arthur B. Emmons, 2d, M.D., Director, Harvard Mercantile Health Work, Boston, Mass.
Discussion by *Harold W. Stevens, M.D.*, Jordan Marsh Co., Boston, Mass.
4. Occupational Diseases and the Physician in Industry.
A. G. Cranch, M.D., National Carbon Co., Cleveland, Ohio.
5. Studies of Undernourishment in Industry.
William Hall Bunn, M.D., Youngstown, Ohio.
Discussion by *R. W. Elliott, M.D.*, National Lamp Works, Cleveland, Ohio.
6. Importance of Periodic Physical Examinations, with Reports on 3,000 Examinations.
William B. Fisk, M.D., Chief Surgeon, International Harvester Co., Chicago, Ill.
Discussion by *R. S. Quinby, M.D.*, Hood Rubber Co., Watertown, Mass.

Tuesday, May 23.

9:30 A. M. at Washington University Medical School.

1. The Practical Application of the Activities of the Public Health Service to the Problems Affecting Industry and Industrial Physicians.
L. R. Thompson, M.D., Surgeon in Charge, Division Industrial Hygiene, U. S. Public Health Service, Washington, D. C.
2. Surgical Reconstruction (illustrated).
R. Tunstall Taylor, M.D., Professor of Orthopedics, Johns Hopkins Medical School, Baltimore, Md.
3. The Heart in Industry.
Paul D. White, M.D., Chief of the Medical Out-Patient Departments and in Charge of the Cardiac Clinic, Massachusetts General Hospital, Boston, Mass.
Discussion by *Arthur E. Strauss, M.D.*, St. Louis, Mo.
4. The Relation of Inguinal Hernia to the Workmen's Compensation.
J. M. Wainwright, M.D., Chief Surgeon, Glen Alden Coal Co., Scranton, Pa.
Discussion by *Loyal A. Shoudy, M.D.*, Bethlehem Steel Co., Bethlehem, Pa.
5. Unusual Fractions and Dislocations with End Results (illustrated).
C. W. Hopkins, M.D., Chief Surgeon, Chicago & Northwestern Ry., Chicago, Ill.
Discussion by *George D. Cale, M.D.*, St. Luke's Hospital, St. Louis, Mo.
6. Atmosphere, Efficiency and Civilization.
Ellsworth Huntington, Department of Geological Sciences, Yale University, New Haven, Conn.
7. What Should the Industrial Physician Know about Nervous and Mental Diseases?
Frankwood E. Williams, M.D., National Committee for Mental Hygiene, New York.

(Cafeteria lunch served in the restaurant of the Medical School.)

2:00 P. M.

1. Election of Officers.
2. The Relation of Syphilis and Gonorrhea to Industry.
William F. Snow, M.D., General Director, American Social Hygiene Association, New York.
Discussion by *A. V. Thomson, M.D.*, New York.
3. Industrial Groupings and Tuberculosis.
William Charles White, M.D., Director, Tuberculosis League, Pittsburgh, Pa.
4. The Industrial Phase of the Tuberculosis Problem.
Frank A. Craig, M.D., Physician in Charge of Industrial Work, Henry Phipps Institute, Philadelphia, Pa.
5. Industrial Results of Granite Dust Inhalation.
D. C. Jarvis, M.D., Barre, Vt.

ANNOUNCEMENT OF SUMMER COURSE IN REHABILITATION

BY

GRADUATE SCHOOL OF EDUCATION, HARVARD UNIVERSITY; NATIONAL TUBERCULOSIS ASSOCIATION; AMERICAN OCCUPATIONAL THERAPY ASSOCIATION; INDUSTRIAL REHABILITATION DIVISION, FEDERAL BOARD FOR VOCATIONAL EDUCATION; AND NATIONAL COMMITTEE FOR MENTAL HYGIENE.

We take pleasure in announcing a course in the Rehabilitation and Reëducation of Handicapped Persons, during the summer session of Harvard University, July 10 to August 19, 1922, under the direction of Mr. W. I. Hamilton, assisted by specialists.

This course is offered as a broad basal course for those who are working with or intend to work with the handicapped. Among those who should find it profitable are occupational aides in hospitals, teachers of the handicapped, "after-care" nurses, workers in employment bureaus for the handicapped, agents of state rehabilitation services and of the Veterans' Bureau, and others interested in rehabilitation as a part of a constructive social program.

Mr. Hamilton is Industrial Research Secretary of the National Tuberculosis Association. For three years prior to joining the staff of that association, he was in charge of the training of disabled soldiers with the Federal Board for Vocational Education.

July 12-21
Aug. 14-17 Mr. Hamilton's lectures will cover the following topics: social and economic foundations; growth of the idea of rehabilitation; interrelations of phases of work from the time the disability is incurred until rehabilitation is attained; legal aspects; psychological approach in occupational therapy and prevocational work; determination as to training and selection of job objective; the "mental" case and rehabilitation; training methods; the place of institutional training, "job" training and other types of training in a rehabilitation scheme; special problems as related to the blind, deaf and speech-defect cases, the nervous and mentally disabled; desirable future developments.

With Mr. Hamilton will be associated:

Mr. John A. Kratz, Chief, Industrial Rehabilitation Division, Federal Board for Vocational Education.—five lectures—the meaning of rehabilitation as defined in the Federal Act and the activities for which it provides; the scope, limitations and methods of national and state rehabilitation services; cooperative relationships between rehabilitation services and other state agencies, such as compensation commissions maintenance, co-operation with other helpful agencies in the several states, including medical associations, industrial physicians, hospital staffs and organized social and relief agencies.
July 24-28

Dr. H. A. Pattison, Supervisor of Medical Service, National Tuberculosis Association,—five lectures—physical reconstruction and prosthetic appliances; medical aspects of rehabilitation; scope; care and relationships, including occupational therapy, treatment, "after-care" and employment, with special reference to the tuberculous.
July 31-Aug. 4

Mr. F. G. Elton, District Director, New York State Rehabilitation Service,—five lectures and discussions on case methods and procedure in rehabilitation.
Aug. 7-11

Dr. F. E. Williams, Associate Medical Director, The National Committee for Mental Hygiene; Editor, *Mental Hygiene*—two lectures—essential elements in conduct disorder; mental handicaps in the physically disabled; special problems in the rehabilitation of the mentally handicapped; recognition of mental handicaps; possibilities in rehabilitation.
Aug. 14-15

Students enrolling in the course will have opportunity to study actual cases of rehabilitation and methods of rehabilitation as conducted in the vicinity of Boston.

In addition to the regular morning lectures, opportunity will be provided each week for one or more group conferences, in which phases of the work will be fully and informally discussed. Each student seeking credit toward a degree will be required to present one thesis of from three to five thousand words, the subject of which will be agreed upon with Mr. Hamilton. Upon the acceptance of the thesis and the passing of the customary examination, this course will be accepted as a half course for a graduate degree and also for the degree of A.A.

The announcement of courses in the Harvard University Summer School may be obtained by writing to the Graduate School of Education, Harvard University, Cambridge, Massachusetts.

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A PRELIMINARY NOTE ON DYSMENORRHEA AS AN INDUSTRIAL PROBLEM*

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DYSMENORRHEA is the commonest of all female ailments. With the increasing employment of women in industry, it is timely to consider the industrial aspects of this condition. Two problems at once present themselves. The first is to determine the industrial incidence of dysmenorrhea—the extent to which industry is crippled from this cause. The second problem is to discover how the situation can most efficiently be handled.

INCIDENCE

From the purely clinical point of view, it is sometimes difficult to say just what degree of menstrual discomfort is to be rated as dysmenorrhea. From the industrial point of view, the definition of the term is simple. In this sense dysmenorrhea is any catamenial disability which lessens the efficiency of the employee.

Industrial crippling from dysmenorrhea may occur in three ways: (1) A girl may do her work without complaint, but with a lowered general efficiency. (2) A girl may begin her work, but be compelled in the course of the day to report to the rest room or hospital. (3) A girl may stay at home for a full day, or longer.

Statistics in regard to the first group of cases are not obtainable. Certainly this group in the aggregate does not account for any considerable industrial loss. Possibly in the occasional case of a skilled individual worker or executive the lowered efficiency might be noticeable.

In regard to the second group of girls, those who report to the rest room or hospital, data are easily available. Table 1 contains figures which have been obtained from four large industries—a factory, two department stores, and a telephone exchange. From these figures it appears that, on the average, rather over 10 per cent. of the girls in an industrial establishment may be expected to seek relief for their menstrual dis-

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abilities during any given month. Naturally, there are many factors which may influence this figure. The age, nationality, and general type of the girls, the attitude of the firm and its executives, and the feeling existing among the employees toward the medical department, might all tend to increase or decrease the average figure in the case of any particular industry.

TABLE 1—GIRLS REPORTING TO REST ROOM OR HOSPITAL

Industry	Period	Total Number of Girls	Average Number per Month Reporting for Dysmenorrhea	Per Cent. Reporting
A	1919	2,141	152	7.1
	1920	2,385	131	5.6
B	Oct.-Dec., 1920	750	81	10.8
C	Oct.-Dec., 1920	600	80 (estimated)	13.3
D	December, 1914	1,000	153	15.3
	March-Sept., 1919	1,000	122	12.2

In regard to the number of "repeaters" who report month after month, the figures in Table 2 are offered, from which interesting conclusions can be drawn. Out of 1,750 girls, 96 reported three or more times during eleven months, making a total of 441 visits. In this particular organization, 12 per cent. of the total employees reported per month. In eleven months, then, 0.12 x 1,750 x 11, or 2,310 visits were made to the hospital because of dysmenorrhea. But 441 of these visits were made by the 96 "repeaters," and

TABLE 2.—NUMBER OF "REPEATERS" AMONG 1,750 GIRLS DURING ELEVEN MONTHS

2 girls reported 10 times
4 " " 9 "
3 " " 8 "
6 " " 7 "
16 " " 6 "
10 " " 5 "
8 " " 4 "
47 " " 3 "

so 1,869 must have been made by 1,654 other girls, of whom many undoubtedly came once only, and none came more than twice. It follows, therefore, that at least three-fifths, and probably nearly four-fifths of the female staff had occasion, sometime during the year, to report because of menstrual troubles. The comparatively small number of "repeaters" recorded in Table 2 may be explained by the fact that the industrial plant from which these figures were obtained is one of the few that makes a practice of interrogating prospective employees about their catamenial disability, and of rejecting those who admit being regularly incapacitated.

When we consider the disposal made of the girls who report to the hospital, figures from the different industries are strikingly in agreement. Nearly one-half of all those reporting receive a hot drink, and return to their work after resting ten or fifteen minutes; thus, the amount of lost time is negligible. Somewhat less than one-half lie down for varying periods of time, ranging from fifteen minutes to four hours; the average time actually lost from work in these cases is about two hours. About one-eleventh of the girls reporting are sent home for the rest of the day; the industrial loss in such a case should be reckoned as nearly a full day, since such work as may have been done before reporting is usually no great contribution to the efficiency of the industrial machine.

It is most difficult to obtain figures in regard to the third group of cases, those who stay at home altogether for

a full day or longer. In nearly all industrial plants short absences, for less than three days, are listed as being "for personal reasons," and a more detailed statement of the cause is not required. At the same time, this is the most important group, both from the economic and from the medical point of view. Table 3 is based on periodic absences

TABLE 3.—PERIODIC ABSENCES AMONG 356 GIRLS DURING SIX MONTHS

11 girls stayed out	6 times
31 " " "	5 "
41 " " "	4 "

at intervals of twenty-eight days, which were, therefore, in all probability due to dysmenorrhea.

How many girls stayed out for the same reason three times, twice, or once in the six months it is, of course, not possible to tell from the records. It is a very conservative estimate to assume that fifty stayed out three times, fifty twice, and sixty once, in the half-year. Allowing these figures, which err, if at all, on the side of being too small, then we have a total of 695 days lost among 356 girls during a period of six months. The total days of work during this period were 64,080, so that the industrial loss caused by this group of girls exceeds 1 per cent. of the total time of the employees.

Tabulating the foregoing observations, it becomes very obvious that the third group of cases is the one chiefly responsible for industrial loss from dysmenorrhea (Table 4).

Management

In this connection two opportunities are offered to the industrial physician. The first is the chance to provide proper care for those girls who come voluntarily to the hospital. The second and larger opportunity is along lines of education, particularly among the worst cases, such as those who stay at home.

In most instances where an industry has an organized medical department, the first of these opportunities is fairly well met. The necessary arrangements include a room with cots, sufficiently isolated from observation and disturbance. A tactful nurse is in attendance, and the physician is available for severe cases, or those who wish to see him. Hot-water bottles or electric heating-pads are at hand, and sanitary napkins are provided when needed. There is a supply of malted milk or other ingredients for hot drinks, as well as a selection of suitable drugs. Whether these last may be administered by the nurse, in accordance with fixed directions, is a question to be settled by each physician.

TABLE 4.—LOSS PER MONTH OF TWENTY-FIVE WORKING DAYS PER 100 GIRLS

	Days Lost
Group I	
(Loss not reckonable; probably negligible).	....
Group II	
Subgroup A—10% of 100 report; ½— of these lose practically no time..........	....
Subgroup B—10% of 100 report; ½— of these lose 2 hours each................	1+
Subgroup C—10% of 100 report; 1/11 of these lose 1 day each.................	1—
Group III	
1% of total working days..................	25

The possibilities of the second opportunity are large, from both the industrial and the medical points of view. Women are amazingly backward about seeking relief for their menstrual difficulties. The aggregate of unnecessary suffering which is silently borne every month is dreadful to contemplate. Tradition dictates that this is part of woman's lot, and will probably improve after marriage, and the inertia of false modesty adds the final inhibiting touch. The purpose of this paper is not to discuss the treatment of dysmenorrhea; it

is sufficient to say that the greater part of such suffering can be prevented by simple measures, and in most cases without a pelvic examination. The problem is to bring this fact to the knowledge of the girls, and to impress upon them the desirability of having their trouble corrected.

Nowhere else is there such an opportunity as in industrial medicine to spread propaganda of this sort. And yet the physician must proceed with considerable tact and caution, for resentment would certainly be aroused by the idea that such investigations were being forced upon female employees. There are two occasions when the subject could be properly introduced—at the time of hiring, and again when a girl reports to the hospital for dysmenorrhea. If our figures are correct, nearly four-fifths of the female staff would be reached in the latter way during the course of a year. Good news spreads fast, and a few cured patients are excellent advertising.

The attitude of employers seems to be, for the most part, one of indifference. Either they do not appreciate the extent of the problem, or they consider it impossible of solution through the machinery of industrial medicine. If they are enlightened on both of these points their co-operation in any scheme of improvement should be assured.

The first need is to train the physician in the industrial aspects of dysmenorrhea, as well as in the diagnosis of the different clinical types and in the ordinary therapeutic measures. Without such fundamental knowledge there can be no successful handling of the problem.

I wish to thank the different industrial physicians who have so kindly helped me in obtaining statistics and other information on this subject.

ANALYSIS OF 123 CASES

OF

ANTHRAX IN THE PENNSYLVANIA LEATHER INDUSTRY*

HENRY FIELD SMYTH, M.D., DR.P.H.

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AND

ELIZABETH BRICKER, M.D.

Medical Inspector, Department of Labor and Industry, Pennsylvania

IN connection with a recently completed survey of the anthrax hazard in the tanning industry in Pennsylvania, accounts of which are to be published elsewhere (1) (2), we have tabulated 123 cases of human anthrax traceable to the materials handled. It is the purpose of this paper to make an analysis of the data obtained in connection with these cases.

For the purposes of this study the tanneries in which these anthrax cases originated may be divided into two classes: those handling cattle hides, and those handling goat skins. Cattle hides are received green salted, dry salted or earth dried. The green salted hides are tied individually in square bundles with the hair side in, and the dried hides are in bales. Green salted hides give rise to practically no dust, and therefore are safer to handle in the raw state. Most of the cattle hide tanneries are packer controlled and at present are tanning almost exclusively hides from packer killed cattle, either domestic or South American. These beef cattle are almost sure to be free from anthrax. There are, however, some non-packer hides imported at present and many of these are dry. Anthrax has been caused by handling these dry hides and also by handling green salted non-packer hides. When business conditions return to normal, many more of these non-packer hides will be tanned, as was formerly the case. In 1921 there were four tanneries using dry hides, and in 1918 there were twelve. Before that time many tanneries handled no other stock.

Raw stock is soaked in water and then in strong lime suspensions, after which it is dehaired and washed, and is ready for tanning. The strong lime soaks rapidly reduce the numbers of anthrax spores on the hides, and the hides are practically free from danger by the time they are dehaired and washed. The occasional anthrax cases occurring in the later departments of the tannery are probably accidental dust or contact infections from these first processes. On this assumption we have figured that in the fifty-seven cattle hide tanneries included in our study, having an estimated working force of 7,458 men, there were 614, or slightly over 8 per cent. of the men, directly exposed to anthrax risk. In the nineteen goat skin tan-

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neries employing 5,881 men, 426, or somewhat over 7 per cent., were directly exposed. This gives a total of 1,040 directly exposed men in the industry, or not quite 8 per cent. of the employees (see Table 1). Of these men at least 119 contracted anthrax in the twelve years included in our study, and four more cases developed in those handling raw hides or skins, making 123 cases in all, or over 11 per cent. of the number of directly exposed tanners. Seventy-three of these cases were due to the handling of cattle hides (Fig. 1), and fifty to the handling of goat skins.

No cases of anthrax have as yet been traceable to the handling of domestic hides, with the exception of one case in 1918 from Texas hides. Table 2 indicates the source and condition of hides being handled in the twenty-eight cases among cattle hide tanners and the four cases among goat skin tanners in which we have definite information on the subject. This table shows anthrax traceable to hides from Texas, India, China, Mexico, South America and Cuba, in twelve or more cases from dry hides, but in two of them from green salted hides. In many cases among cattle hide tanners and in most cases among goat skin tanners we could obtain no records as to the source or condition of skins handled at the time.

Hides and skins being imported into this country are supposed to come in under quarantine unless accompanied by a consular certificate stating that they are from a district free from anthrax. Our experience agrees with that of others to the effect that this certification is worse than useless since it merely establishes a false sense of security among the tanners and freight handlers. Reference to Table 2 will show that four of the reported cases are known to have been contracted from handling certified hides. Indeed, one of us has cultured anthrax a number of times from samples from certified materials (2).

TABLE 1.—TANNERS EXPOSED TO ANTHRAX

Tanneries	Total Employees	Exposed to Anthrax	
		Number	Per Cent.
57 cattle hide tanneries	7,458	614	8+
19 goat skin tanneries	5,881	426	7+
Total	13,339	1,040	7.8

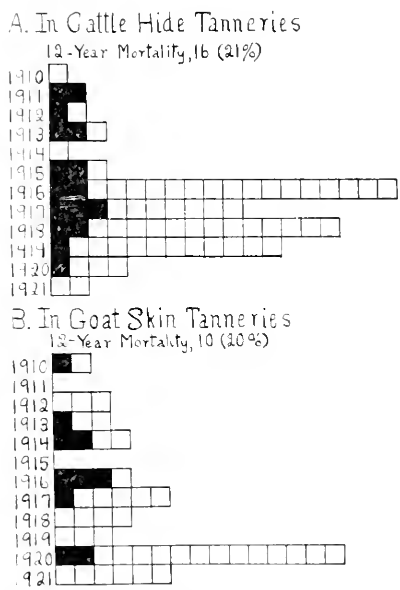

Fig. 1.—Yearly morbidity and mortality from anthrax in Pennsylvania tanneries. Total mortality, 26 (21%). Squares represent cases; black squares, fatalities.

Table 3 shows the distribution of anthrax cases among tanneries. For convenience in differentiation cattle hide tanneries are listed by number, and goat skin tanneries by letter. This table shows anthrax cases in twenty-three of the fifty-seven cattle hide tanneries, or over 40 per cent., there being thirteen with one case each, one with two cases, one with three cases, three with four cases, two with five, one with six, one with nine, and one with fifteen cases in twelve years. The last tannery had two years with five cases, and tannery number 18 had one year with five cases. In this twelve-year period there were sixteen deaths from anthrax in cattle hide tanneries, one tannery losing two cases in one year; fourteen of these sixteen deaths were from eleven tanneries, the other two being in a hide contractor and a freight agent, respectively. In goat skin tanneries cases have been reported from eight out of the nineteen tanneries of this type of which we have any records. In addition, there were seven cases reported among tannery workers but no statement was made as to where they were employed, and two cases were reported in longshoremen handling skins. In this group of tanneries three had one case each, one had two cases, one three, one six, one eleven, and one sixteen cases in the twelve years, with six cases in 1920, and five in 1921.

These records are, we feel, fairly complete from 1916 on. Before that date we feel sure that we must have overlooked a number of cases. Records were obtained from the following sources: Bureau of Labor Statistics, Bulletin No. 267; Pennsylvania State Health Department records; hospital records; and reports from physicians and from tannery superintendents. Health department records are very meager, and many cases are not reported at all. Tannery records, except for recent years, are, we find, very vague both as to date and diagnosis. The best records available were those of hospitals and tannery physicians. The source from which the greatest number of case records was obtained was a physician in central Pennsylvania who treated cases for several of the largest sole leather tannery corporations. His records gave us a number of cases not listed elsewhere, but as furnished us they did not go back beyond 1916. His cases were all treated in his own hospital and the diagnosis was confirmed in the laboratory as were the diagnoses of cases treated in the other hospitals.

Figure 1 shows the cases and deaths listed by years. Here is noticed the great apparent increase in cases in 1916 due to the obtaining of more complete records. The decrease in 1920 and 1921 in cases from cattle hide tanneries is due

TABLE 2.—SOURCE AND CONDITION OF HIDES AND SKINS HANDLED BY WORKERS INFECTED WITH ANTHRAX

Raw Material	No. of Cases	Country of Origin	Dry or Wet	Certified
Cattle hides	1	Texas	—	—
" "	2	India	dry	
" "	9	India and China	dry	—
" "	1	China and South America	dry	—
" "	12	South America	2 green salted	3 certified
" "	1	South America and Mexico	dry	certified
" "	1	Mexico	dry	—
" "	1	Cuba	dry	—
Goat skins	4	India	wet salt	—

TABLE 3.—ANTHRAX CASES IN TANNERIES[1]

A Cattle Hide Tanneries

Tannery No.	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	Tannery No.
1	1 (1)								1				1
2		1 (1)											2
3		1 (1)					5	3		5 (1)	1		3
4			1 (1)										4
5			1				2				2		5
6				1									6
7				1 (1)				1 (1)		2			7
8					1								8
9						3 (2)	1						9
10							2		2	1			10
11							1		3				11
12							1 (1)						12
13							3 (1)	1	2				13
14							1						14
15							1	1			1 (1)		15
16								1 (1)					16
17								1					17
18								1	5 (1)	1		2	18
19								1 (1)					19
20									1				20
21									1				21
22										1			22
23										1			23
Not traceable to any tannery				1 (1)[2]			1 (1)[3]			1			Not traceable to any tannery

73 cases in 23 tanneries; 16 deaths in 11 tanneries.

B Goat Skin Tanneries

Tannery No.	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	Tannery No.
A	1										4 (1)	1	A
B			1		1								B
C				1 (1)									C
D				1						1	1		D
E							1	2	1	1	6 (1)	5	E
F							1 (1)						F
G								4 (1)	2	1	4		G
H									1				H
Not traceable to any tannery	1		2 (1)[4]	1	3 (2)[5]		2 (2)						Not traceable to any tannery

50 cases in 8 tanneries; 10 deaths in 5 tanneries.

[1]Numbers in parentheses represent fatalities.
[2]Freight agent.
[3]Contractor.
[4]Longshoreman.
[5]One longshoreman.

to business depression and decrease in importation of non-packer hides liable to contain anthrax. As stated above, we feel that this condition is only temporary.

Table 4 shows the effect of hospitalization resulting from early diagnosis on mortality rates and on time lost in non-fatal cases. This table includes cases from both groups of tanneries. It shows that of the ninety-seven cases which were hospitalized only ten, or about 10 per cent., died, while of the twenty-six cases which were not hospitalized sixteen, or over 61 per cent., died. As a complement to this there is also shown the number of cases in which we have a record of laboratory diagnosis. Only two cases that were so diagnosed were not sent to a hospital, possibly because the diagnosis was made too late, as both patients died. The neglect to make a laboratory confirmation of a diagnosis of anthrax in a tannery employee is inexcusable. The diagnosis by smear, culture or animal inoculation is simple and unmistakable, yet we have a record of a fatal case not included in this list, that of a patient dying in a large hospital in the state, whose death was reported on the certificate as due to anthrax merely because he was a tannery worker. A search of the records showed a laboratory diagnosis, by blood culture and smear, of staphylococcus septicemia. This developed from an infected wound made by running into the hand a splinter from a new loft stick used for tanned hides. This occurred in a tannery handling nothing but packer hides and in an employee handling only tanned hides. Such errors would be fewer if a little more care were exercised in history taking.

Not only is a hospitalized case more apt to get good nursing and the required absolute rest and supportive treatment, but it is also more apt to receive intelligent specific treatment of some kind. As such a large proportion of these cases were so hospitalized and as each hospital as a rule used one specific method of treatment, we have a good opportunity to throw some light on the relative merits of treatment methods. In the state of Pennsylvania the cases of which we have treatment records group themselves into three divisions: Some received serum injections; some, injections of 25 or 50 per cent. phenol in the next vascular area to the carbuncle; and in some cases the lesions were excised. These methods of treatment were used alone or in varying combinations which have been recorded in Table 5.

TABLE 4.—RESULTS OF HOSPITALIZATION FOR ANTHRAX

Hospital No.	Total Cases	Deaths		Recoveries		Record of Time Lost in Non-Fatal Cases	
		No.	Per Cent.	No.	Per Cent.	No. of Cases	Average No. of Days
1	39	4	10.25	35	89.75	31	43.8
2	7	0	0.0	7	100.0	7	31.8
3	1	0	0.0	1	100.0	1	60.0
4	46	4	8.7	42	91.3	36	32.1
5	2	2	100.0	0	0.0	—	—
6	2	0	0.0	2	100.0	2	39.0
Total hospitalized	97	10	10.3	87	89.7	77	37.3
Total non-hospitalized	26	16	61.5	10	38.5	5	55.4
Laboratory diagnosis recorded	99	12	12+	—	—	—	—
No record of laboratory diagnosis	24	14	58+	—	—	—	—

Regan, in a recent article (3), makes

a strong plea for the exclusive use of serum locally and generally, claiming the best results from this method. He reports eight successful cases so treated, without a death, and quotes a long series of reports from different parts of the world showing a total mortality of 6.7 per cent. in 446 cases, exclusive of his own. Our Pennsylvania statistics show a general mortality of over 21 per cent. but the hospitalized cases show a mortality of a little over 10 per cent. One hospital, where the routine treatment consists of 25 per cent. phenol injections and wet bichloride of mercury dressings, has treated seven cases without a death, a record practically as good as Regan's. In eighty-six of the Pennsylvania cases the local lesion was excised, ten of the patients dying—a mortality of 11.6 per cent. Of the eighty-six cases, thirty-seven which were treated in a large city hospital received serum injections also, but in five instances the disease was fatal—a mortality of 13.5 per cent. Forty-seven of the patients treated by excision also received 50 per cent. phenol injections around the wound, and five of these died—a mortality of 10.6 per cent. Of the thirteen patients not having the lesion excised, four died, or 30.7 per cent. Two patients treated by excision alone both recovered.

Of a total of forty-three cases receiving serum treatment, nine were fatal, giving a mortality of 20.9 per cent., which is much higher than the average mortality quoted by Regan. Of fifty-six patients not receiving serum, five died, or 8.9 per cent., a mortality less than half that for the cases receiving serum. The high mortality of the serum treated cases is due to one fatal case receiving serum and phenol injections and three fatalities among the five cases receiving serum alone. Of the thirty-seven patients receiving serum and also having the local lesion excised, only five died, giving a mortality of 13.5 per cent. Thirty-four of these cases, four of them fatal, were treated in one large city hospital, giving a mortality of under 12 per cent., a very fair record for this number of cases. Next to the seven successful cases treated in one hospital by phenol injections and local antiseptic dressing, the best record obtained was in the forty-seven cases treated by excision and phenol injections, with a mortality of 10.6 per cent. Forty-six

TABLE 5.—RESULTS OF SPECIFIC TREATMENT METHODS

Treatment	No. of Cases	Deaths		Recoveries		Record of Time Lost by Non-Fatal Cases	
		No.	Per Cent	No.	Per Cent	No. of Cases	Average No. of Days
Serum alone	5	3	60	2	40	1	31.0
Serum and phenol injections	1	1	100.0	0	0	—	—
Serum and excision	37	5	13.5	32	86.5	28	45.2
Total serum	43	9	20.9	34	79.1	29	44.7
Total without serum	56	5	8.9+	51	91+	44	32.4
Excision alone	2	0	0	2	100.0	1	47.0
Excision and serum	37	5	13.5	32	86.5	28	45.2
Excision and phenol injections	47	5	10.6	42	89.4	36	32.1
Total excisions	86	10	11.6	76	88.4	65	36.9
Total without excision	13	4	30.7+	9	69.2+	8	31.7
Phenol injections alone	7	0	0	7	100.0	7	31.8
Phenol and serum	1	1	100.0	0	0	...	...
Phenol and excision	47	5	10.6	42	89.4	36	32.1
Total phenol	55	6	10.9	49	89.1	43	32+
Total without phenol	44	8	18.1+	36	81.8+	30	44.8
No record of specific treatment	24	12	50.0	12	50.0	9	52.2

of these cases were treated by one man, with only four fatalities, a mortality of under 9 per cent., and an excellent record, especially as a number of these cases occurred in small towns, some over a hundred miles from the physician's office, to which they were transported by train or by automobile. This record would not be possible if it were not that the tanners have been on a constant lookout for anthrax infection and that they send cases for diagnosis on the earliest development of a suspicious lesion. The very great value of early diagnosis is seen by comparing these figures with New York City anthrax mortality statistics for 1915 to 1919, quoted by Regan (3), which show a mortality for the five-year period ranging from 26 per cent. in 1918 to 75 per cent. in 1916. These New York cases were mostly shaving brush infections having no connection with the patient's occupation and therefore usually not diagnosed as anthrax until a generalized bacteremic condition had developed. The great improvement shown by the 1920 mortality rate of 8.5 per cent. is undoubtedly largely due to the prompt, liberal use of serum, as Regan claims, but it is contributed to largely by the earlier diagnosis due to the publicity given to the likelihood of this mode of infection.

In addition to the mortality figures given above for the Pennsylvania cases, Tables 4 and 5 show records of time lost by eighty-two non-fatal cases, seventy-seven of which were treated in hospital, with an average of 37 days' lost time, and five were not hospitalized, with an average of over 55 days' lost time. Treatment in hospital evidently shortens materially the duration of illness and incapacity, as well as enhancing the probability of recovery. In no non-hospitalized case was the patient away from his work for less than 31 days, while the shortest time lost among the hospitalized cases was 7 days. In twenty-three cases, or practically 30 per cent. of the hospitalized cases for which we have time-lost data, there was a loss of 25 days or less per case. Consideration of time-lost data in cases treated by those methods for which we have records of seven or more cases show twenty-eight non-fatal cases treated by excision and serum injection, with an average loss of 45.2 days; thirty-six non-fatal cases treated by excision and phenol injections, with an average loss of 32.1 days; and seven non-fatal cases treated by phenol injection and bichloride dressing, with an average loss of 31.8 days. The shortest disablement period in the first group was 14 days, four of the men (14 per cent.) losing 25 days or less. In the second group the shortest period was 7 days, with sixteen men (44 per cent.) losing 25 days or under. In the third group of seven cases the shortest time lost was 13 days, and the next, 25 days (30 per cent.). As against the average loss of 44.7 days for twenty-nine patients receiving serum injections, we have an average loss of only 32.4 days for the forty-four patients not receiving serum. Against an average loss of 36.9 days for sixty-five patients having the local lesion excised, we have an average of only 31.7 days for the eight cases with no excision, but this group is too small to base much evidence upon, as is the group of seven included in it, which received only phenol injections. Against the average loss of 32+ days for the total of forty-three patients receiving phenol injections, we have an average loss of almost 45 days for the patients not receiving phenol.

The above figures are not offered as an argument against the use of serum,

but rather as an argument for the value, in good hands, of local treatment by excision and by the use of phenol subcutaneously, at least where serum is not available. In the hands of one private physician and of one city hospital, in no way connected with him and in a different part of the state, phenol injections without serum seem to have given excellent results, both from the standpoint of time lost and from that of cure—results practically as good as the most favorable results reported by others from the use of serum intensively. We would state also that the resultant scarring in the cases treated by phenol injections, which we were able to examine, was remarkably inconspicuous, considering the extent of the lesion as evidenced by photographs.

As further evidence of the seriousness of the anthrax risk for exposed tanners, we ask consideration of Tables 6 and 7.

TABLE 6.—TIME LOST BY NON-FATAL CASES OF ANTHRAX

	DAYS
Total non-fatal cases in 12 years	98.0
Average time lost (reports of 82 cases)	38.36
Total estimated time lost	3,759.28
Average estimated time lost per year	313.27
Greatest estimated loss in any tannery (16 cases	613.76
Greatest estimated loss in any tannery in any one year (6 cases)	230.16

Table 6 considers the question of time lost in non-fatal cases. We have records of an average of 38.36 days lost in eighty-two non-fatal cases. This would give an estimated time loss of 3,759.28 days in twelve years in the ninety-eight non-fatal cases, of which we have records, or an average yearly loss for the industry of 313 days. One tannery with a total of sixteen cases would have lost, on this basis, 613.76 days, and with six cases in one year, over 230 days in a single year.

Table 7 gives the morbidity rate among the directly exposed employees for the five years, 1916 to 1920, inclusive, during which period we feel that we have fairly complete and representative statistics. This table shows an average of almost 2 per cent. per year of exposed employees contracting anthrax. The risk is apparently somewhat greater in cattle hide tanneries than in tanneries handling goat skins, in spite of the evident greater prevalence of anthrax infested skins among the raw stock of the goat skin tanneries. There seems to be an idea prevalent among many of the cattle hide tanners that the risk is much greater in the handling of goat skins than in the handling of cattle hides. This is true under the present conditions of the industry, as evidenced by the figures for 1920 and 1921, but, as argued before, this is probably only a temporary condition due to the lack of demand for sole leather. The slightly lower mortality rate among goat skin tanners, as shown in Figure 1, is probably due to early diagnosis and prompt hospitalization, since these tanneries are all in or near Philadelphia and have immediate access to first-class hospitals, and several of the largest of them employ their own physicians. The great increase in the incidence of infection in goat skin tanneries in 1920 is interesting, and has been explained by the tanners in two ways. Owing to the increased demand for leather during the war and the great increase in prices paid for raw materials, many more skins were collected and many inferior skins were baled, which ordinarily would have been refused. The great delays in shipping of all freight overseas caused many of these inferior skins, often infested with anthrax, to be held for a year or more in transit or on open docks ex-

posed to the weather. This resulted in water damage and increase in anthrax in already infested bales. Many of these skins reached the tanneries in 1920.

Cultures made from dust and soak water samples as part of the survey yielded virulent anthrax from 6 per cent. of the cattle hide tanneries and over one-half of the goat skin tanneries where samples were taken, and in many cases these cultures represented so-called certified, supposedly anthrax-free stock (2).

In the discussion of treatment no special mention of internal anthrax was made, as there has been only one case among the 123 cases of anthrax which have occurred in Pennsylvania in the past twelve years, and that case occurred in 1915 in a tannery handling dry cattle hides at the same time, and was, of course, fatal. We have no record as to treatment.

Table 8 gives the occupations of the 123 victims of anthrax. Those listed as laborers are almost all, if not all, workers handling raw or wet-untanned stock. This table shows 111 of the cases among those referred to previously as directly exposed to anthrax risk, only three of the cases being surely in a later department of the tannery. It will be noted that seven men in all have been infected while doing repair work around soak vats. The two cases in housewives are interesting as showing how it is possible for a tanner to take his hazard home with him in his work clothes. Both of these women were tanners' wives, one infecting herself by a needle prick while mending her husband's overalls, and the other presumably becoming infected while doing her husband's wash. These

TABLE 7.—ANTHRAX MORBIDITY IN TANNING INDUSTRY IN PENNSYLVANIA, 1916-1920

Year	Cattle Hide Tanneries		Goat Skin Tanneries	
	No. of Cases	Per Cent. of Exposed Employees[1]	No. of Cases	Per Cent. of Exposed Employees[1]
1916	18	2.9+	4	0.9+
1917	10	1.6+	6	1.4+
1918	15	2.4+	4	0.9+
1919	12	1.9+	3	0.7+
1920	4	0.6	15	3.5+
Five-year total[2]	59	9.6+	32	7.5+
Yearly average[3]	11.8	1.9+	6.4	1.5+

[1]See Table 1.

[2]Five-year total for both types of tannery=91 cases, or 8.7+%, of exposed employees.

[3]Yearly average for both types of tannery=18.2 cases, or 1.7+% of exposed employees.

TABLE 8.—KIND OF WORK DONE BY INFECTED EMPLOYEES

Occupation	Total No. of Cases, 1910-1921	Cattle Hide Tanneries	Goat Skin Tanneries
Handling dry skins	25	12	13
Handling wet skins	22	3	19
Laborers	64	53	11
Finishing	2	1	1
Repairing or tearing down	7	4	3
Hair house	1	0	1
Housewives	2	0	2
Total	123	73	50
Cases among persons directly exposed	111 10.6% of exposed employees	68 93.1% of cases of anthrax	43 86% of cases of anthrax

...es offer a strong argument in favor of requiring the disinfection, on the tannery premises, of all work clothing.

Summary and Conclusions

This report lists 123 cases of anthrax connected with the tanning industry in the twelve years from 1910 to 1921, inclusive. This number represents almost 12 per cent. of the directly exposed employees. The mortality among these 123 cases was over 21 per cent.

In the five-year period for which we have accurate statistics, there was a yearly morbidity rate of almost 2 per cent. of the directly exposed employees. The directly exposed employees include those handling raw stock and those soaking and liming this stock.

Anthrax has been contracted from the handling of non-packer cattle hides from Texas, Mexico, China, India and South America, and from goat skins from many regions.

Anthrax has been contracted from the handling of both dry and wet salted hides and skins, and from both certified and uncertified stock, and anthrax bacilli have been isolated from both. The present practice of certification offers little or no protection to the tanner.

The mortality of cases treated in hospitals has been considerably less than one-half that of unhospitalized cases.

In Pennsylvania apparently the best results of treatment have been obtained by the injection of strong phenol solutions (25 to 50 per cent.) locally around the area of the initial lesion, with or without excision of the lesion.

The use of antianthrax serum with excision of the local lesion has also given excellent results, and we do not desire to create the impression that it should not be used. We would be inclined, from a consideration of the Pennsylvania experience, to advocate the continued intensive use of a reliable serum subcutaneously or intravenously, combined with excision of the local lesion and the injection of concentrated phenol solution around the wound. Early diagnosis, prompt hospitalization if possible, and absolute rest are essential for success in any form of treatment.

Anthrax continues to be a decided menace to both the cattle hide and goat skin tanner and will continue to be so until some method is developed whereby tanneries cease to receive anthrax infested raw stock.

Seymour-Jones (4) advocates for England the prohibition of the importation of any raw stock not previously converted to the wet salt state by means of his formic acid and mercuric chloride method. One of us discusses more fully the subject of disinfection for anthrax in another paper (2), but whatever method may be finally adopted, we feel very strongly that all undisinfected imported stock should be disinfected at one or more centrally located government disinfecting stations before being shipped to the tanners, as the English government is doing at present with wool and hair.

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EXPERIMENTS IN AIR CONDITIONING*

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[illegible] Harvard [illegible]

As a class exercise in the course in ventilation in the School of Public Health of the Harvard Medical School, it was desired to study by direct experimentation certain phases of air conditioning. The White machine of the National Air Treating Company was admirably adapted for our purposes and was kindly loaned by the company for experiments.

The machine consists of a metal tank 2 feet by 2 feet by 14 inches, above which is mounted a 1/6 horse power Holtzer-Cabot direct current shunt motor driving through bevel gears, a special centrifugal pump and a shaft perforated with holes for throwing the water from the pump out in a fine spray into the spray chamber. In the machine used for demonstration, the spray chamber walls are made of glass. The air enters this chamber through a series of closely spaced, herring-bone baffles, through which the water is returned to the tank. The exit air is freed from entrained water by passing through a like series of baffles to the 1,500 cubic feet per minute exhausting fan which is driven by a direct-connected 1/12 horse power Holtzer-Cabot direct current shunt motor. Both motors run at 1,700 revolutions per minute, 115 volts, while the pump motor is rated at 1.2 amperes and the fan motor at 1 ampere. The motors are connected in parallel and are designed for constant speed, so that starting the machine consists in merely plugging into a standard socket.

The only instrument on the machine for temperature measurement is a thermometer on the pump line to show the temperature of the water entering the spray chamber. This is really all that is needed.

All tests were run in the same room, selected without any particular regard to general thermal conditions, position of ventilators, radiators or windows. The radiator was shut off for all runs and heat was supplied on Test 4 only from a gas furnace across the top of which air was blown by an electrically driven fan. This fan was kept in place and run at the same speed for all tests. The fan and air conditioning machine were so placed as to cause the minimum of air currents, and both were run at full speed at all times. All instruments were read from the same position relative to the fan furnace and air conditioning machine. The ventilators were blocked off and no external source of ventilation was used. The doors were kept closed. Four men were present in Tests 1 and 4, and five men for Tests 2 and 3.

The outdoor temperature was well below freezing both days these tests were run, and a large window about [illegible] feet by 8 feet gave abundant space for condensation during the "humidifying" tests. No attempt was made to obviate this.

For the last three tests, an [illegible] was used for both emptying and filling the tank of the White machine, so that not more than five to ten minutes elapsed between stopping one run and starting [illegible]

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the next. In all cases the water level of the tank was kept at as nearly 11 inches as possible. This was equivalent to 4.56 cubic feet, or 20.39 pounds of water per inch.

No tests were made with the tank water at a relatively high and constant temperature, nor were any tests made with a dehumidifying agent at temperatures below 32° Fahrenheit.

Instruments Used

Relative Humidity. — Relative humidity was determined with a "Tycos" sling psychrometer of the U. S. Weather Bureau type, and checked with a portable motor-fan psychrometer and a hair psychrometer, designated a "sling," "motor" and "hair," respectively. The sensitivity of the last instrument was surprising, in view of the wide range of conditions prevailing.

The relative humidity of the moist air delivered from the White machine is not shown on the curves, although wet and dry bulb readings are given in the tabulated results. Regardless of conditions in the room, this exit air is saturated to such a high degree that its determination by wet and dry bulb is difficult and unreliable. It was found impossible to keep the dry bulb dry for more than a few seconds at a time, although water lost by entrainment appeared to be low. The manufacturers claim a relative humidity of over 90 per cent. for this exit air, which appears to be a conservative estimate, while a variation of a few per cent. either way would have little effect on the rapidity with which the desired atmospheric conditions can be obtained.

Air Temperatures. — For both the exit air from the machine and the room air the dry bulb readings are shown on the curves. For the room air the dry bulb readings of the sling and motor-fan psychrometer are averaged.

Water Temperatures. — Readings were taken with a long-stemmed thermometer, the water being thoroughly stirred before each reading. It was found that these readings for run 1 checked those of the thermometer (provided by the manufacturers) in the water intake of the machine so closely that reading of the latter was dispensed with, since the machine was so placed for our tests as to make this reading inconvenient.

Cooling Power of the Air.—Hill's wet and dry kata-thermometer offers a method of determining the cooling power of the air with reference to body temperature, and is described in detail in his monograph on "The Science of Ventilation and Open Air Treatment." This instrument, in brief, consists in an alcohol thermometer with a relatively large bulb of definite surface area and stem of about 1 mm. bore, on which 95° and 100° F. are marked. The bulb is held in hot water until the alcohol, colored red for visibility, has partly filled a small reservoir at the top of the stem, and thus formed an unbroken column. The bulb is then withdrawn and, in the case of the wet kata, excess water removed by pinching the bag at the top. The dry bulb is wiped dry with a clean cloth. The time for the alcohol to fall from the 100° to the 95° mark is then taken in seconds, and the "kata factors," marked on the stems of the instruments, are divided by this time, giving the cooling power of the air, with reference to body temperature, in millicalories per square centimeter per second.

As this instrument is quite sensitive to temperature variations, care must be taken to keep it well away from the body and, for tests such as these, in a definite

location with respect to drafts, to which it is very sensitive. It is advisable to use the mean of several readings, and where this is not possible, as in our tests, at least two sets of instruments should be read simultaneously.

Although at first glance the figures and curves of our kata readings appear to cover a rather wide range without special relation to each other, it will be seen that they show maximal and minimal points at about the same times, which, in turn, bear a definite relation to the humidity readings.

For locations in which the comfort or hygienic aspects of humidity and temperature are the important consideration, the kata-thermometer is useful in connection with wet and dry bulb readings, while for problems of air drying at atmospheric or even reduced pressures the kata-thermometer affords information obtainable with the wet and dry bulb psychrometer only by considering the total heat in the air.

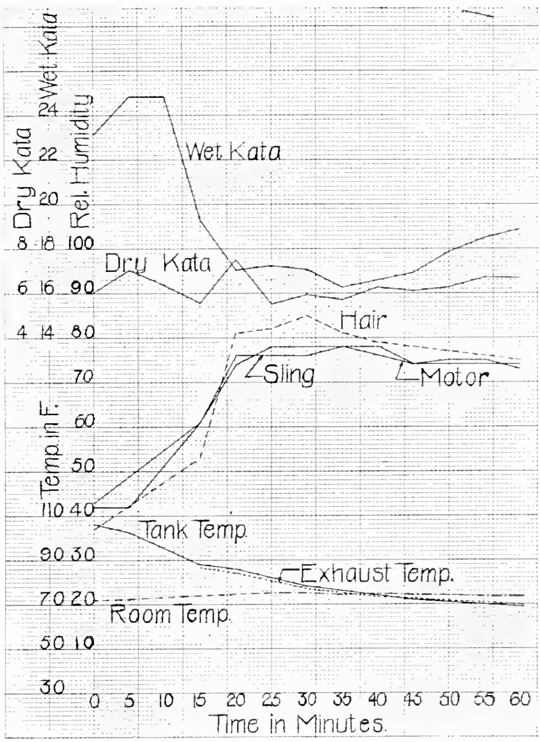

Fig. 1.—Test 1, humidifying. Tank water at initial temperature of 106° F. No attempt to humidify quickly.

Test 1.—In the first test it was desired to find how quickly and to what extent the room could be humidified when using water at an initial temperature of only 106° F. When the

motors were started the relative humidity was 55 per cent., and was raised to 77 per cent. in ten minutes. The preliminary rise in humidity during the first twelve minutes was due to evaporation from the tank water, as a small hose was used in this run. It will be seen from the curves and data of this test that there is a gradual falling off in humidity after the maximum point is reached, and that this drop in humidity accompanies the drop in temperature of the tank water. The kata-thermometers both show a rise in cooling power as the humidity decreases.

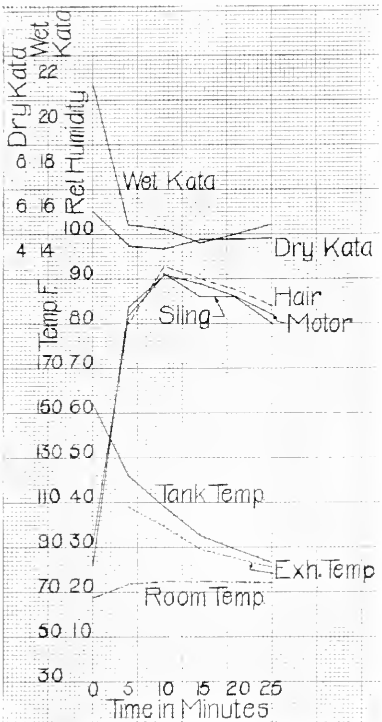

FIG. 2.—Test 2, humidifying. Tank water at initial temperature of 154° F. Humidifying quickly and allowing tank temperature to fall until approximate equilibrium was reached.

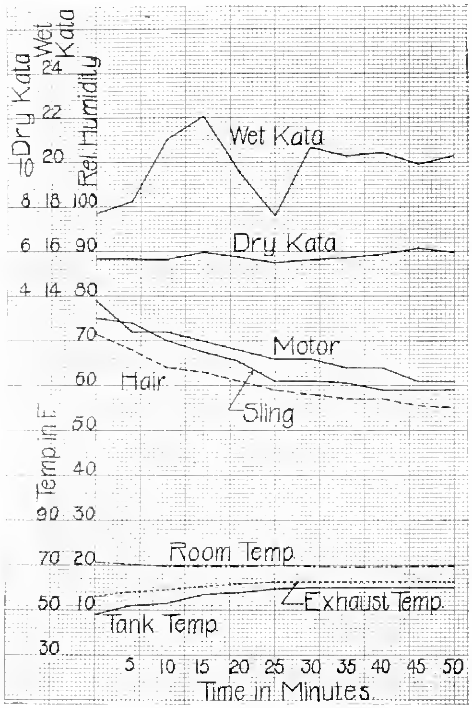

FIG. 3.—Test 3, dehumidifying. Tank water at initial temperature of 48° F. Ordinary tap water used. Test stopped on reaching approximate equilibrium.

TEST 2.—The rapidity with which a high degree of humidity can be reached is well shown in this test. With an initial humidity of 26½ per cent., a maximum of 91 per cent. was reached in ten minutes, with a rise in room temperature of only 9°. This figure could have been maintained by keeping the temperature of the tank water high enough to reach a predetermined equilibrium. A consideration of the curves of this test show that the speed of humidification is greater than in Test 1 owing to the higher initial temperature of the tank water. This is most clearly shown by superimposing the curves of Test 2 on those of Test 1.

TEST 3.—Using ordinary tap water in the tank of the White machine, it was desired to see how quickly and to what extent the room could be brought to ordinary conditions. Test 3 was accordingly started with a relative humidity of

72 per cent., and the tank water at 48° F. Dehumidification occurred slowly but with regularity until the tank water reached 59° F., at which point equilibrium was gradually being reached.

tinually adding snow and withdrawing water. The run was started as soon as a temperature of 32° F. was reached in the tank, and at the same time the gas furnace was lighted and regulated to keep the temperature of the room

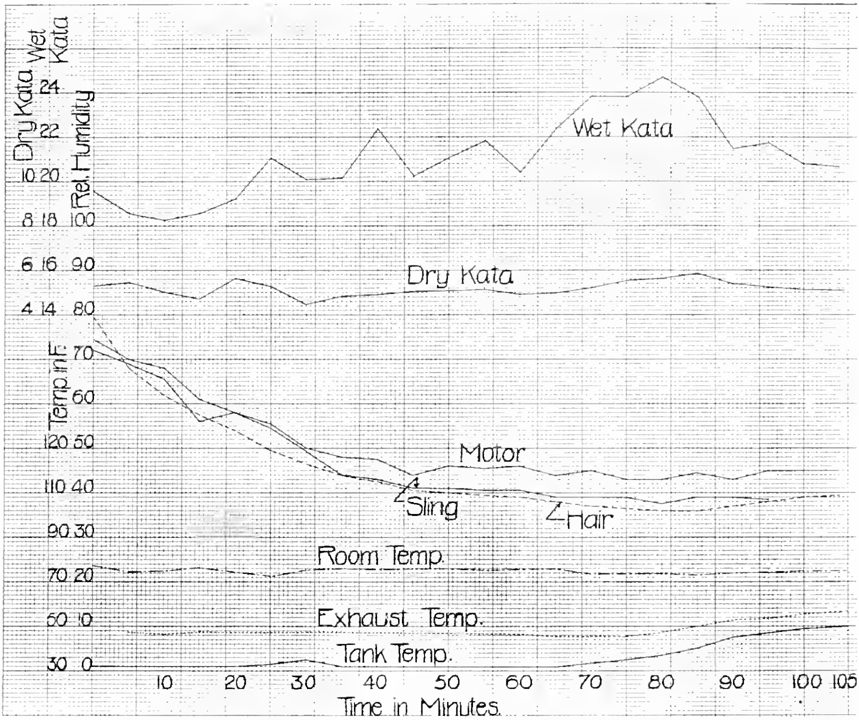

Fig. 4.—Test 4, dehumidifying. Tank water kept at 32° F. for 60 minutes, then allowed to rise to show corresponding rise in relative humidity. Note that exhaust temperature and relative humidity do not rise for some minutes later.

Test 4.—For use during hot and humid summer days, a machine of this type is called upon to reduce humidity and to keep it at a predetermined figure. To exaggerate conditions prevailing on disagreeable and uncomfortable summer days, the relative humidity of the room was rapidly raised by running the machine for a few minutes with hot water, then emptying it quickly, and refilling with cold water and snow. This mixture gave a tank temperature of 32° F., which was maintained for the first sixty minutes of the test by continually adding snow and withdrawing water.

as nearly constant as possible. Without some source of heat, it is impossible to dehumidify rapidly and at the same time keep up the room temperature to ordinary conditions. The rate of dehumidification is best shown by superimposing the steeper curves of this test on the more gradual ones of Test 3. In order to observe the rise in relative humidity after the equilibrium point was approximately reached, the tank temperature was allowed to increase, and at the same time the gas furnace was turned down lower.

TEST 1.—FEB. 15, 1922

Humidifying

Barometer = 30.12 inches.
Wet kata factor = 521.
Dry kata factor = 548.

Tank Temperature	Relative Humidity							Kata Thermometers				Exhaust Air		Time
	Motor			Sling			Hair							
°F.	W.	D.	%	W.	D.	%	%	Secs. W.	Cooling Power	Secs. D.	Cooling Power	W.	D.	P.M.
106.0	58.0	72.0	42	58.5	72.0	43	37	22.5	23.17	111	6.04	—	—	2.00
102.5	58.5	72.5	42	—	—	—	—	21.0	24.82	90	7.01	—	—	2.05
—	—	—	—	—	—	—	—	21.0	24.82	103	6.38	—	—	2.10
88.0	65.0	74.0	61	65.0	74.0	61	53	27.08	19.25	123	5.60	86.0	86.9	2.15
86.0	69.0	75.0	74	69.0	74.5	76	81	27.08	19.25	123	5.60	86.0	86.9	2.15
82.0	70.0	75.0	78	69.5	75.0	76	82	30.2	17.25	124	5.56	77.9	80.6	2.25
78.0	70.0	75.0	78	69.5	75.0	76	85	30.6	17.05	113	5.96	75.2	77.0	2.30
76.0	70.0	75.0	78	69.0	74.0	78	81	32.1	16.24	119	5.74	73.4	75.2	2.35
74.0	69.5	75.0	76	69.0	74.0	78	79	—	—	105	6.29	71.6	73.4	2.40
72.0	69.0	75.0	74	68.0	74.0	74	78	30.8	16.92	109	6.12	70.7	72.5	2.45
71.0	68.5	74.5	74	68.0	73.5	75	77	29.2	17.84	105	6.29	69.8	71.6	2.50
70.0	68.0	74.0	74	67.5	73.0	75	76	28.2	18.48	96	6.71	68.9	70.7	2.55
69.0	68.0	74.0	74	67.0	73.0	73	75	27.5	18.86	97	6.66	68.0	69.8	3.00

TEST 2.—FEB. 16, 1922

Humidifying

Barometer = 29.51 inches.
Dry kata factor = 521.
Wet kata factor = 548.

Tank Temperature	Relative Humidity							Kata Thermometers				Exhaust Air		Time
	Motor			Sling			Hair							
°F.	W.	D.	%	W.	D.	%	%	Secs. W.	Cooling Power	Secs. D.	Cooling Power	W.	D.	P.M.
154	52.0	68.0	31	50.0	67.0	26	27.0	25.3	21.68	86.5	6.03	—	—	2.35
122	70.0	74.0	82	70.0	73.5	84	80.0	35.6	15.4	115.0	4.53	107.6	108.02	2.40
108	73.0	75.0	91	72.5	74.5	91	93.0	36.0	15.22	119.0	4.375	99.5	99.5	2.45
95	72.5	75.0	89	71.5	74.5	86	90.0	37.5	14.61	109.0	4.78	89.15	89.6	2.50
89	72.0	75.0	86	71.5	74.5	86	87.5	36.5	15.0	109.0	4.78	84.2	85.1	2.55
83	70.5	74.5	82	70.0	74.0	80	84.0	35.5	15.44	106.0	4.82	79.7	81.5	3.00

TEST 3.—FEB. 16, 1922

Dehumidifying

Barometer = 29.51 inches.
Dry kata factor = 521.
Wet kata factor = 548.

Tank Temperature	Relative Humidity							Kata Thermometers				Exhaust Air		Time
	Motor			Sling			Hair							
°F.	W.	D.	%	W.	D.	%	%	Secs. W.	Cooling Power	Secs. D.	Cooling Power	W.	D.	P.M.
58.0	63.0	70.0	68	62.0	69.5	65.5	61.0	30.9	17.72	92.0	5.67	55.4	56.1	3.10
57.0	63.5	70.0	70	62.5	69.5	67.5	63.0	30.0	18.26	92.0	5.67	56.3	58.1	3.15
53.0	64.0	70.0	72	63.0	69.5	70.0	64.0	26.0	21.08	92.5	5.64	57.2	59.0	3.20
52.0	65.0	71.0	72	64.5	70.0	74.0	68.0	25.8	22.1	87.0	5.99	58.1	60.8	3.25
48.0	67.0	71.5	79	66.0	71.5	75.0	71.5	28.0	19.56	91.5	5.73	59.0	61.7	3.30
59.5	62.5	70.0	66	61.5	70.0	64.0	59.0	31.1	17.61	94.5	5.51	59.9	62.6	3.35
60.0	62.5	70.0	66	61.0	69.5	61.0	58.0	26.4	20.78	93.0	5.61	59.9	62.6	3.40
60.0	62.0	70.0	64	60.5	69.0	60.5	57.0	27.0	20.3	91.0	5.725	59.9	62.6	3.45
60.0	62.0	70.0	64	60.0	69.0	59.0	57.0	26.8	20.45	88.6	5.88	59.9	62.6	3.50
60.0	61.5	70.0	61	60.0	69.0	59.0	55.5	27.5	19.94	85.0	6.14	59.9	62.6	3.55
60.0	61.5	70.0	61	60.0	69.0	59.0	55.0	27.0	20.3	87.0	5.99	59.9	62.6	4.00

TEST 4.—FEB. 16, 1922

Dehumidifying

Barometer = 29.51 inches.
Dry kata factor = 521.
Wet kata factor = 548.

Tank Temperature	Relative Humidity							Kata Thermometers				Exhaust Air		Time
	Motor			Sling			Hair							
°F.	W.	D.	%	W.	D.	%	%	Secs. W.	Cooling Power	Secs. D.	Cooling Power	W.	D.	P.M.
32	71.5	77.5	74.5	70.5	77.0	72.0	79.5	28.0	19.58	98.5	5.29	—	—	4.33
32	68.0	75.0	70.0	67.0	74.0	69.0	68.0	29.5	18.58	95.4	5.47	45.5	47.3	4.38
32	67.5	75.0	68.0	66.5	74.5	65.5	62.0	30 0	18.27	103.5	5.04	44.6	46 4	4.43
32	66.5	76.0	61.0	66.0	77.0	65.0	57.5	29.5	18.58	110.0	4.74	45.5	47.3	4.48
32	65.0	75.0	58.0	64.0	74.0	58.0	54.0	27.5	19.23	92.3	5.65	45.5	47.3	4.53
33	63.0	73.5	55.5	61.0	71.5	54.5	49.5	26.0	21.07	98.5	5.29	—	—	4.58
35	63.5	76.0	50.0	62.0	75.5	49.5	46.5	27.0	20.1	117.0	4.455	45.5	47.3	5.03
32	63.0	76.0	48.0	62.0	76.0	44.0	44 0	25.0	21.9	108.0	4.83	46.4	47.3	5.08
32	62.5	75.5	47.5	61.5	76.0	43.0	42.5	24.5	22.37	106.0	4.92	—	—	5.13
32	62.0	76.0	44.0	61.0	76.0	41.0	40.5	27.0	20.27	103.0	5.06	—	—	5.18
32	62.5	76.0	46.0	61.0	76.0	41.0	40.0	26.0	21.08	102.0	5.11	—	—	5.23
32	62.5	75.5	45.5	60.5	75.5	40.5	39.5	25.1	21.81	101.0	5.16	—	—	5.28
32	62.5	76.0	46.0	60.5	75.5	40.5	39.0	26.8	20.42	106.0	4.91	42.8	46.4	5.33
32	62.0	76.0	44.0	60.5	76.0	39.0	38.0	24.5	22.36	104.5	4.99	42.8	45.5	5.38
—	61.0	74.5	45.0	58.0	73.0	39.0	37.0	23.0	23.82	100.0	5.21	41.9	45.5	5.43
35	60.0	74.0	43.0	58.5	73.5	39.0	36.5	23.0	23.82	94.3	5.54	41.9	45.5	5.48
37	60.0	74.0	43.0	58.0	73.5	37.5	36.0	22.2	24.7	92.3	5.65	43.7	47.3	5.53
40	60.0	73.5	44.5	58.0	73 0	39.0	36.0	23 0	23.82	89.0	5.86	46.4	50.0	5.58
45	60.0	74.0	43.0	59.0	74.0	39.0	37.0	25.5	21.5	96.5	5.40	49.1	52.7	6.03
47	60.5	74.0	45.0	59.0	74.5	38.5	38.0	25.2	21.78	99.5	5.24	50.0	53.6	6.08
49	61.5	75.0	45.0	—	—	—	39.0	26.3	20.82	101.5	5.14	51.8	55.4	6.13
50	61.5	75.0	45.0	—	—	—	39.5	26.5	20.7	102.0	5.11	52.7	56.3	6.18

Summary

From these tests it will be seen that a portable air conditioning machine is well adapted to demonstrations and study of variations in relative humidity and temperature. Experimental demonstrations such as these, in which students take part, can easily be amplified to include physiological studies on the effect of temperature, humidity, carbon dioxide, etc.

EXPERIMENTAL OBSERVATIONS UPON THE RELATION BETWEEN ATMOSPHERIC CONDITIONS AND THE PRODUCTION OF FATIGUE IN MINE LABORERS

(Continued)

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Method of Tests

The methods proposed and adopted were:

1. To register the output of work by suitable ergometers under various atmospheric conditions to be found on the surface and at several places underground.

2. To take an ergographic record of each subject before and after each day's work, exhausting one small group of muscles, such as the flexor muscles of the middle finger as previously explained, and by this means to estimate the degree of general fatigue produced by the work.

3. To find to some extent the physiological effects on the subjects, by taking skin temperature, body temperature (by mouth), and loss of weight during part of the tests at least.

4. Atmospheric conditions were determined by wet and dry bulb temperatures, by wet and dry kata-thermometer readings, and also by general observations as to air motions, etc.

It was our intention to have, say, two natives working on ergometers, and to spend, perhaps, a week in each of four or five different positions, commencing on the surface and progressing from the best to the worst conditions underground, then reversing the order of progression and finishing up again on the surface. The set of tests in the reverse order was intended to be a check on the effects of training or practice. After this, comparative tests, such as tests of effects of rest and of a meal during working hours, were to be carried out in the best and worst places underground. The same series was intended to be carried out with a second pair of natives, and, if time permitted, with a third pair, to eliminate effects of individual idiosyncrasies. As will appear later, however, events occurred which limited the tests to one pair of subjects.

Choice of Apparatus

In the previous tests carried out by the Sanitation Department, Rand Mines, there was a good deal of evidence, such as loss of weight and signs of fatigue, to show that the work involving the greatest expenditure of energy and production of fatigue was that of the hammer boy, and therefore an ergometer on which this class of work could be registered was highly desirable.

It was thought at first that an ergometer to register work similar to hand drilling could be made with a very stout helical spring fixed at one end in a rigid frame, and provided at the other end with an anvil piece which would re-

ceive the impact of the blow from the jumper; the deflection of the spring would give an indication of the energy in each blow—to be determined exactly by calibration—the deflections to be recorded by a pencil connected to the anvil piece and bearing up against a moving roll of paper. It was found after a few trials that the recoil from a spring with a suitable deflection was so great that it made normal hammering impossible; and, moreover, that it would be impossible to get a smooth record from a pencil attached to such a spring. So the spring method was abandoned.

Another method was tried with better success, and was ultimately adopted. The ergometer finally adopted is shown in Figure 4. A is a steel disk about 3/16 of an inch thick with a boss B to receive the jumper. This forms the cover of a shallow cast steel vessel C and is clamped by a ring D with bolts. Vessel C is connected by a pipe to an engine indicator E; a stand-pipe F is joined by a T-piece to the connecting piece at the lower end and to a water reservoir G at the upper end, a disk with a small orifice H about 1/32 of an inch in diameter being interposed in the stand-pipe a few inches from the lower end. The whole was filled up with boiled water, the air escaping from a plug J in the steel disk. K is a tripod frame fitted with a tube to guide the jumper. When a blow from the hammer is communicated by the jumper to the disk, the lat-

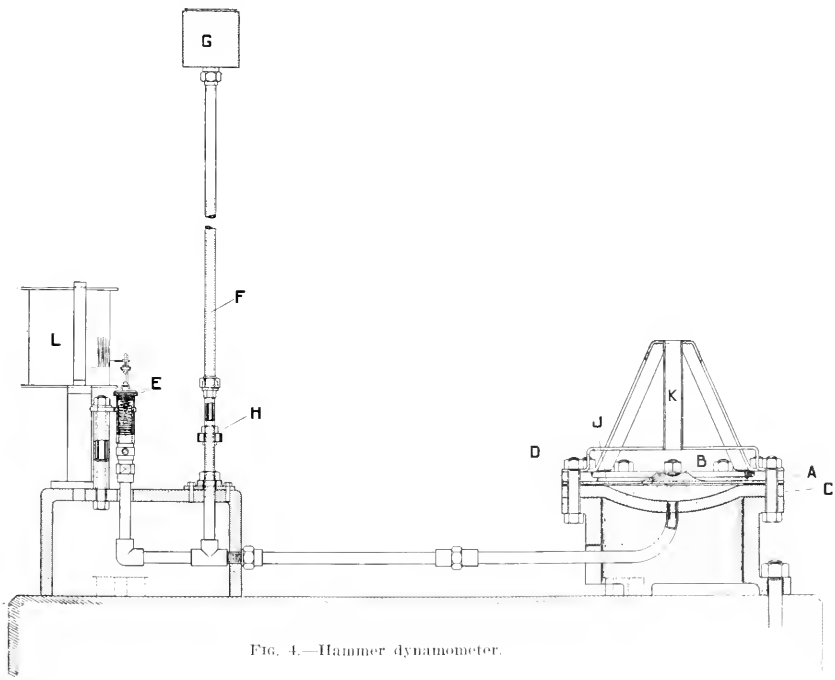

FIG. 4.—Hammer dynamometer.

ter is deflected inward to the vessel and an impulse accompanied by *displacement* passes along the pipe to the indicator, the piston of which is displaced upward by an amount depending on the violence of the hammer blow. There is a rebound of the disk and, consequently, of the indicator piston; then they both reach equilibrium again in a small fraction of a second. As the piston takes a small film of water with it at each stroke, this loss is made up from the reservoir G, which has the additional function of keeping a steady pressure inside the machine. The small orifice H prevents the impulse from the hammer disk from losing its energy in the stand-pipe. The indicator pencil is lightly held by elastic bands against a roll of paper L moved by a machine specially made for the purpose. Figure 5 shows the general arrangement with the position of the native.

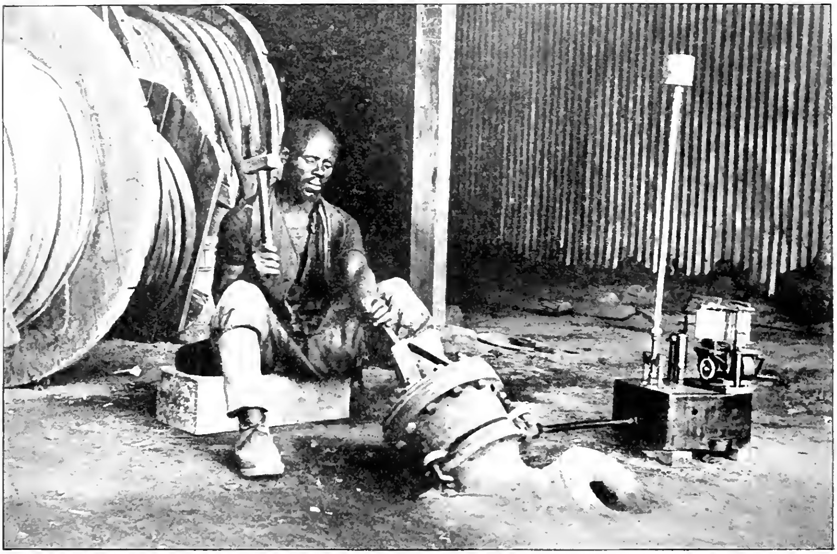

FIG. 5.—General arrangement of hammer dynamometer with position of native.

Figure 6 shows a sample of the record taken. The whole line including the rebound was utilized, as this gave not only greater amplitude but better definition, the zero being somewhat indefinite, especially as the pencil was chisel-

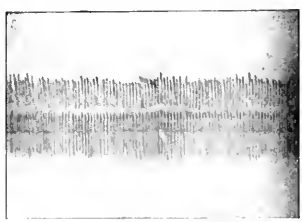

FIG. 6.—Sample hammer dynamometer record.

edged to avoid frequent sharpening. The calibration was performed by drop-

ping, from various heights, a weight equal to that of the hammer used, making at the same time an indicator record. A curve was then plotted giving the relations of the indication to the energy of the blow, the latter being calculated from the weight and height through which the weight fell.

The indication seemed to obey no simple law; on simple theoretical grounds, it should have varied with the square root of the energy of blow, and this it did approximately. Momentum seemed to play some part, as an 8-pound weight falling 2 feet did not give the same indication as a 4-pound weight falling 4 feet, though the energy is the same in each case. The dead weight of the jumper, and to some extent of the disk itself, would, of course, be a factor in the case. The calibration was therefore carried out with a weight equal to the hammer used, about 4.34 pounds, and with the same weight of jumper as was used during the tests.

To prevent the stresses due to impact from producing brittleness in the anvil disk with danger of cracking and change of indication, the disk was changed and annealed after being used for a week, a calibration being made at the beginning and end of each week. The jointing ring between the disk and the flange of the vessel was also renewed every week.

Unfortunately, it was found that the indication was liable to variation, due to many factors besides the energy of the hammer blow, such as the viscosity of the water which varied with the temperature, the condition of the jointing ring, any slight obstruction in the connecting pipe, the presence of small bubbles of air, the friction of the indicator piston, etc. As the indication was small with a strong spring in the indicator, a light spring had to be used which made the effect of friction of the indicator quite appreciable.

It was only by extreme care and attention that these factors could either be eliminated or kept constant during a week's working tests and the calibrations, and as the observer had his attention fully occupied in taking readings during the tests and attending to the recording machine, etc., it is not surprising that errors crept in, which rendered a day's or even a week's tests utterly unreliable, and consequently necessitated the discarding of the results.

Another drawback to this form of ergometer, which would apply to *any form* of machine registering hammer blows, is the fact that it has to withstand the shock of over 14,000 heavy blows each working day; consequently, its construction has to be very robust and it must be bolted firmly to a solid foundation. The setting up, dismantling and calibrating of this machine each week occupied a considerable amount of time so that it was possible to get only four working test days each week.

The second ergometer, or "rotary" machine, was essentially a band-brake dynamometer driven like a winch. Figure 7 shows a section of this machine. A is the brake pulley driven through the spur gearing B from the driving crank; C is a leather belt hung over the pulley. In order to eliminate the errors and the trouble of reading a spring balance on the light tension end of the belt, weights W and w were used, one on each side, and the equilibrium of the belt obtained by making the friction self-adjusting. This feature was obtained by studding one-half of the belt with metal rivets, the heads projecting inside and making contact with the pulley instead of the belt. If the friction was too great, the

belt was pulled over more onto the rivetted portion, the friction being thereby decreased; if the friction was too small, the belt automatically slipped back, making more leather contact with consequent increase in friction. To avoid having to correct for variations due to by a light band of cotton webbing E. A revolution counter on the driving spindle completed the essentials of the machine. The machine was fixed in position by clamping to a post shown at F. The observer had only to note the weights and to take periodical readings

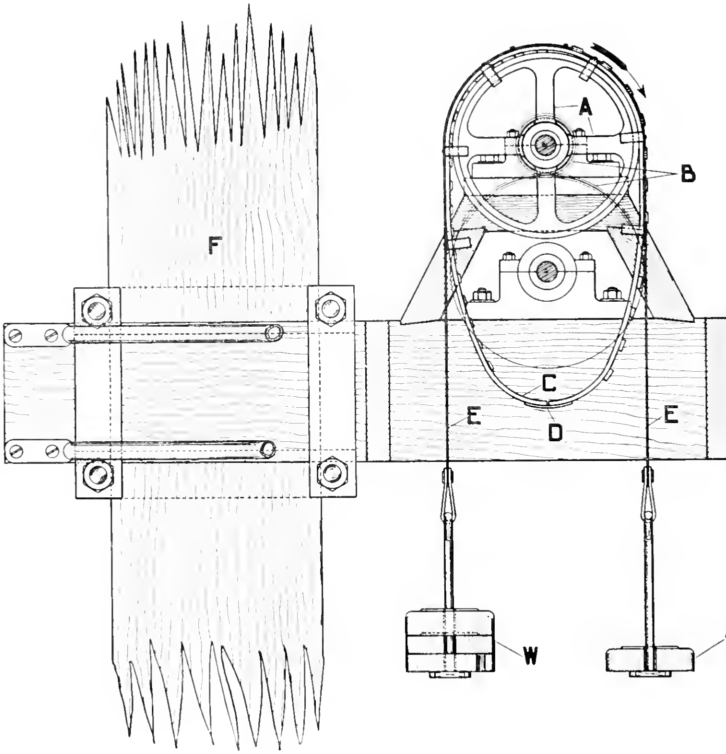

FIG. 7.—Rotary ergometer.

the position of the belt, the latter was balanced, little lead weights being attached on the outer surface of the unrivetted portion to balance the weight of the rivets, the ends of the belt being laced together underneath as shown at D, and the weights W and w suspended of the revolution counter. Every revolution represented so much work done for a certain net pull on the brake pulley, or for a certain difference in the weights.

The machine was calibrated by substituting for the driving crank a narrow

wooden pulley of the same radius, and driving the machine by pulling a cord off this driving pulley, the pull being read on a spring balance. The calibration followed very closely the ordinary straight line law for machines giving mechanical advantage:

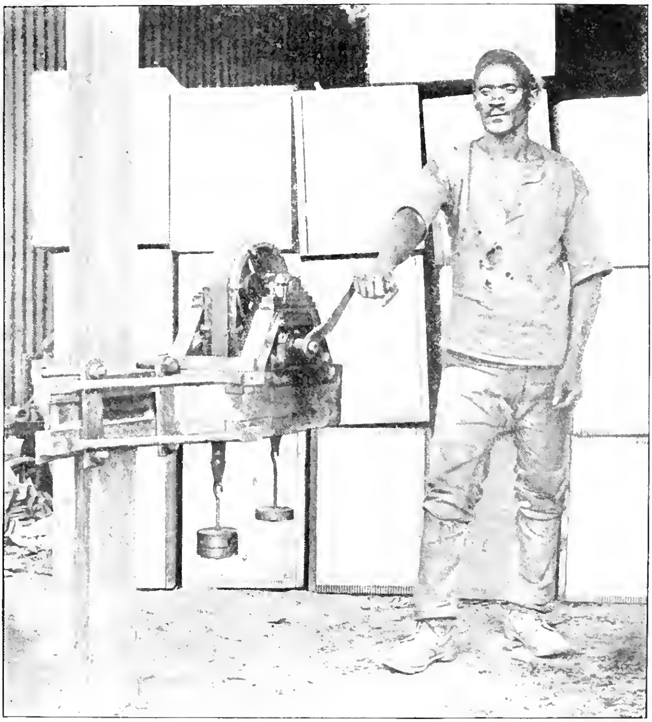

FIG. 8.—General view of rotary ergometer with native

$$P = a\,(W - w) + b$$

where P = force at driving handle

W and w are the large and small weights

a and b are constants

Figure 8 gives a general view of this machine with operator, and shows the method of fixing the machine to a wooden post. The advantages of this machine are its simplicity, accuracy, robustness, reliability, the very little attention it requires, and the ease with which results can be computed. It does not have to withstand heavy strokes like the hammer machine. The winding action is much less wasteful of human motion and energy than the hammering action, hence the results follow more closely the human energy expended. Care, however, has to be exercised in determining the weights to give approximately the "optimum effort and speed." The drawbacks of the machine are that

it does not give a continuous record, that it measures work of a purely unskilled nature, and may not give a correct estimate of capacity for doing work, such as hand drilling, where skill is of considerable importance.

The advantages of the hammer machine over the rotary machine are that it gives a complete record of the day's work, the energy of each blow, and the rate of blows, and shows up any variation throughout the test and any pauses due to fatigue or muscle stiffness; furthermore, it simulates very closely hand drilling, *the type of work which causes the greatest amount of fatigue.* The work being semi-skilled, it brings in the nervous-control factor which is affected by fatigue, thus producing bad hitting or even missing, etc. The computation of results, however, unlike the computation with the rotary machine, was a long, tedious, eye-straining and laborious process.

The finger ergograph adopted is shown in section in Figure 9. It was designed to be used in conjunction with the recording machine used in the hammer machine, and is on the same principle as Mosso's ergograph. The hand and arm are laid on a board A covered with felt, the index and third fingers being placed in straps C to prevent movement, and the middle finger being inserted in a metal clip B which is attached by cords E, E to a weight F. To bring the movements well within the scope of the paper roll used for the hammer machine, the movement of the weight was reduced by a 2 to 1 pulley gear G. The pencil attachment H is fixed to the weight and pressed against the paper roll J. K is simply a jockey pulley to alter the direction of the pull of the cord, and L is a rubber buffer to receive the weight as it comes down after each stroke. Figure 10 gives a picture of the ergograph with the subject's hand in position.

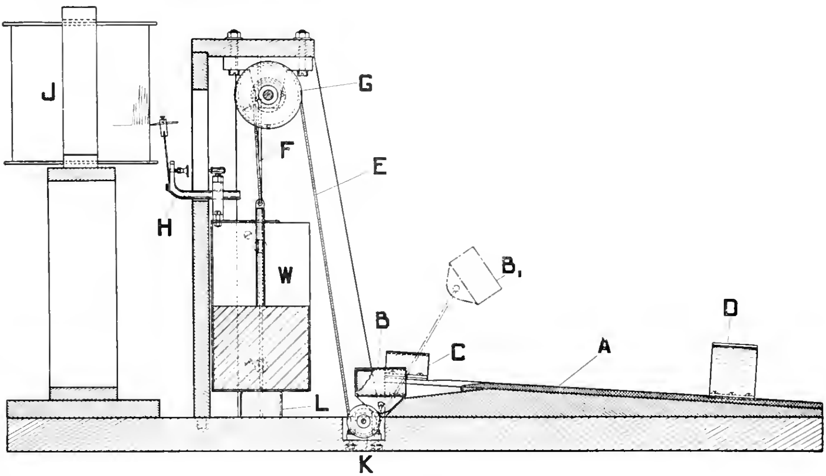

Fig. 9.—Finger ergograph.

At first, a machine was used in which the hand, all but the index finger, was clasped in a vertical plane, the index finger being moved in the same plane raising a weight. This machine was

very light and convenient in some ways, but the action of moving the index finger away from the other fingers is one over which there is not good control and which requires more mental concentration and intelligent use than the flexing of the middle finger. It should be explained here that to make the ergograms strictly comparable, the maximum effort of which the muscles are capable should be exercised at each movement, and it was difficult to get the natives to appreciate that this was wanted. A set of muscles not well controlled requires much more mental concentration to give the maximum effort. Hence the type of machine in which the middle finger was flexed was afterwards adopted, and gave better results. Even this machine, as experience has taught us, is open to grave objections, especially when used with natives. With intelligent men, good results can be obtained when the muscles are properly flexed.

It will be noted that in flexing the middle finger there are three joints involved—the knuckle joint and two others on the finger itself. In proper use of this ergograph the maximum effort and travel should be made by all three joints, the knuckle giving the most travel and requiring most effort, the next joint of the finger giving less travel and less effort, and the first joint of the finger giving very little motion indeed. The tendency of the native was to make the motion one chiefly from the middle joint which required much less effort and which produced much less fatigue—a movement which the subject was sometimes capable of carrying on indefinitely. Moreover, it was impossible to distinguish from the ergogram whether the later movements were partial movements of all three joints or more or less complete movements of the middle joint. The investigators would, if carrying out a similar investigation, make radical changes in the ergograph, and would restrict the movement to one joint only. Electrical, instead of voluntary stimulation of the muscles would, of course, have eliminated the variations due to lack of concentration, etc., but the apparatus required is expensive, complicated, and not suitable for the conditions underground. For these reasons fatigue was estimated not only by ergograph but by observation of physical signs, falling off in rate of work, etc.

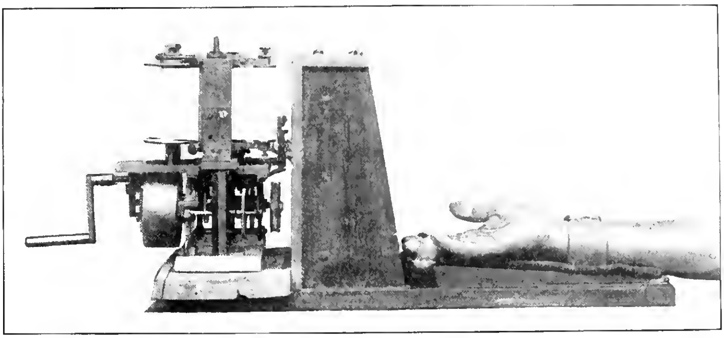

FIG. 10.—Ergograph with subject's hand in position.

Subjects of Test

The natives were chosen for us by Mr. Deakin, Underground Native Supervisor, Village Deep Mines, to whom was explained what qualities were wanted, and who interpreted to the natives what they were required to do. We are indebted to Mr. Deakin, not only for procuring suitable natives, but also for helping on several occasions to make explanations to them and to encourage them to work steadily and cheerfully.

The hammer boy was a Xosa, about 40 years of age, tall, well formed and strong, with finely developed muscles. He possessed alertness, intelligence and initiative well above the average native. His average net weight was about 10½ stones. He was a splendid worker and well trained in the use of the hammer and jumper. His tendency was to keep up a steady rate of hammer blows with almost clock-like precision at a rate of about 61 to 63 blows per minute, the energy of the blow only falling off when considerable fatigue or discomfort set in.

The rotary boy was a Basuto, aged about 35 years, short and sturdy, with an average net weight of about 8¾ stones. He was of rather low intelligence, somewhat dreamy, and without initiative

Both boys were fresh from a six months' holiday; they were free from disease, and had no sickness during the period of tests; they seemed to be of steady, regular habits, and only on few occasions did their condition seem to be affected by incidental factors outside of the working hours. They lived in the compound and had the same rations as the other natives. They usually left the compound about 6 A.M. and returned there about 3 P.M. After some preliminary tests and consultation with mine officials familiar with the work of the natives, it was considered that four hours of continuous work at full capacity was at least as great as the average work performed in actual mining, and this work period was adopted. The observer, native attendant, and test subjects usually went underground from 7 to 7.30 A.M., and after ergograph readings, uncovering and preparation of apparatus. etc., work was generally commenced between 8 and 9 A.M. The test days were usually Tuesday to Friday, Saturday and Monday being required for calibration and changing the outfit to another station.

Working Stations

The stations were chosen, after katathermometer readings had been taken in several places, with a view to giving widely different values of cooling power, consistent with convenience of access, etc., and non-interference with mining work going on, also at sufficient distance from any blasting operations. The positions chosen were:

Surface

1. Cable shed in store yard.

Underground

2. 19 Station near Turf Shaft, depth 4,550 feet below datum level.
3. Stope J. 20 (disused) depth about 4,500 feet, 75 feet from station.
4. 23 Drive East at blind end, depth 5,125 feet, 2,500 feet from station.
5. 24 Drive West at blind end, depth 5,260 feet, 2,500 feet from station.

Depths are given below datum level which is 6,000 feet above sea level.

Results of Tests

Table 3 gives the cooling power (wet and dry), the wet and dry bulb temperature readings, output of work

of hammer and rotary machines, notes on fatigue, clothing, and condition as to perspiration, for the whole series of tests. Figure 11 presents the output and "kata" readings in diagrammatic form. Table 4 gives the weight lost, and mouth and skin temperatures during a part of the series, including the worst and best conditions; the values of cooling power are repeated for near reference.

Figure 12 consists of typical curves showing the rate of output of the rotary machine during the working period. Figure 13 gives outline curves of typical finger ergograms taken before and after work in various working stations. Attention is drawn to the fact that in 19 Station (the best working place underground) the areas of ergograms performed after work are larger than those performed before work, indicating that in these cases there was little or no fatigue produced in the working period. The fact that there was little (in some cases no) diminution in output toward the end of the four-hour working period at this station, especially in the case of the hammer boy, seems to confirm this.

Due to irregularity of work diagrams or calibration curves, for which there were several causes, a large proportion of the figures of output of the hammer machine have had to be discarded as unreliable. This was most unfortunate, as this machine was by far the more expensive, not only in first cost and upkeep, but in attention required and trouble caused; moreover, the hammer boy was the better and steadier worker of the two, and his output in the hotter places, when he showed such great fatigue, would have been valuable information.

It should be noted that the figures of

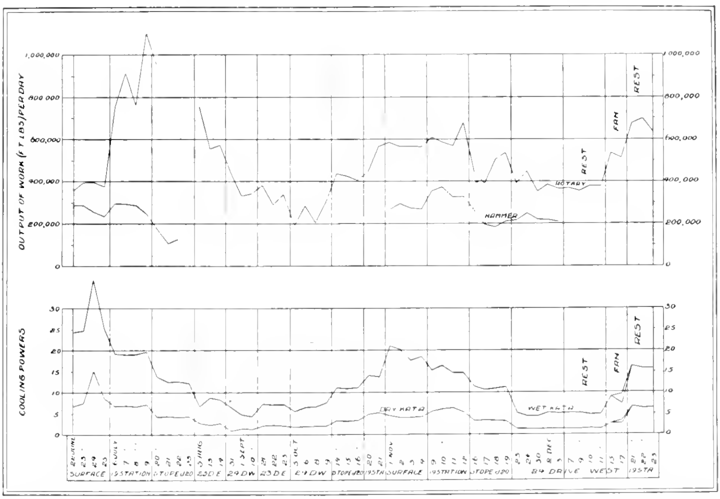

FIG. 11.—Curves showing output of hammer and rotary machines and kata-thermometer readings for work period.

output of the rotary machine for the first tests on the surface, although giving accurately the actual work done, do not give a fair measure of the native's capacity. The observers were somewhat misled by his look of languor and mis-

TABLE 3.—KATA-THERMOMETER AND PSYCHROMETER READINGS, OUTPUT OF WORK, AND CONDITION OF SUBJECTS AS TO FATIGUE, CLOTHING, AND PERSPIRATION DURING ENTIRE SERIES OF TESTS

Date	Position	Average Cooling Powers: Dry "Kata"	Average Cooling Powers: Wet "Kata"	Psychrometer: Dry Bulb	Psychrometer: Wet Bulb	Work Done per Day: Hammer	Work Done per Day: Rotary	Fatigue Conditions After Work: H.B.[2]	Fatigue Conditions After Work: R.B.[3]	How Clothed	Remarks
		Mcalories per sq. cm. per sec.		°F	°F	ft.-lbs.	ft.-lbs.				
6-22-20	Surface	6.8	24.4	54.3 to 64.7	43.9 to 46	288,000	359,000[4]	slight	very slight	Coats on first hour; afterwards, vests, trousers and boots.	No perceptible sweating; cool.
6-23-20	"	7.54	24.6	56.0 to 59.0	41.2 to 43.6	288,000	395,000[4]	"	" "	Same.	Same.
6-24-20	"	15.1	36.7	37.7 to 48.2	29.0 to 33.4	258,000	396,000[4]	"	" "	Coats on all the time.	Cold wind blowing.
6-25-20	"	8.75	25.4	40.3 to 50.8	31.7 to 38.8	234,000	375,100[4]	"	" "	Coats on two hours.	Quite cool.
7-6-20	19 Station	6.8	19.1	62.4	60.2	295,000	753,000	"	slight	Stripped to waist.	Slight sweating.
7-7-20	"	6.94	19.0	62.6	60.1	292,000	912,000	very slight	"	" " "	" "
7-8-20	"	6.65	19.1	62.7	60.2	288,500	765,000	slight	"	" " "	" "
7-9-20	"	7.2	19.7	62.7	60.6	249,000	1,104,000	very slight	"	" " "	" "
7-20-20	Stope J 20	4.27	13.75	75.2	71.8	178,680	953,000	slight	moderate	" " "	Perspiring freely; slight air movement.
7-21-20	"	4.4	12.5	75.2	71.9	103,000	953,000	"	"	" " "	Perspiring freely; rotary not working.
7-22-20	"	4.2	12.5	75.2	71.6	125,000	—	"	"	" " "	Same.
7-23-20	"	4.39	12.1	75.4	71.9			"	"	" " "	"
8-5-20	23 Drive E	2.66	6.7	82.4	80.6		758,000	moderate	"	" " "	Perspiring very freely; cooling power varies, due to pneumatic drill.
8-13-20	"	2.48	8.6	81.7	79.0	—	554,000	"	"	" " "	Perspiring very freely.
8-14-20	"	2.6	8.4	81.3	78.8		570,000	"	"	" " "	Perspiring very freely; air still.
8-31-20	24 Drive W	0.935	5.17	88.2	87.8	—	436,000	"	"	H. B. stripped to waist; R. B. stripped entirely.	Perspiring very freely.
9-1-20	"	1.39	4.84	87.1	86.7	—	330,000	"	"	Both stripped to waist.	" " "
9-10-20	"	1.32	4.35	87.8	87.2	—	340,000	"	"	" " " "	" " "
9-21-20	23 Drive E	2.08	7.32	84.2	82.4	—	380,000	great	great	" " " "	" " "
9-22-20	"	2.32	7.1	84.2	82.4	—	290,000	"	"	" " " "	" " "
9-23-20	"	2.07	7.04	84.2	82.4	—	336,000	"	"	" " " "	" " "
10-5-20	24 Drive W.	1.65	5.56	87.7	86.2	—	192,000[5]	extreme	very great	" " " "	Perspiring very freely. H. B. had to be assisted up to surface.
10-6-20	"	1.92	6.58	86.5	85.3	—	281,000[5]	very great	" "	" " " "	Perspiring very freely.
10-8-20	"	1.98	6.66	87.1	85.9	—	201,000[5]	great	great	" " " "	" " "
10-9-20	"	2.04	7.58	86.7	85.9	—	301,500	very great	very great	" " " "	Perspiring very freely; H. B. played out.

10 14 20	Stope J.20	3 32	11 0	78 8	76 7	—	433,000	moderate	moderate	Both stripped to waist	
10 15 20	"	3 11	10 7	79.9	77 6	—	424,000	"	"	" " " "	
10 16 20	"	3 44	11 0	79 6	77 6	—	401,000	great	"	" " " "	
10 20 20	19 Station	4 9	14.0	68 3	66 7	—	447,750	great	great	H. B. stripped to waist: R. B. armless singlet.	H. B. seemed tired at start; bodies dry, faces moist.
10 21 20	"	5 1	13 7	66 5	65 5	—	567,000	moderate	moderate	Both stripped to waist.	Bodies dry, faces moist.
11 1 20	Surface	4 6	21 0	69 8	56 3	264,000	585,000	moderate	slight	Both boys with singlets, trousers and boots.	No perceptible sweating except at armpits.
11 2 20	"	4 0	20.0	74 5	56 5	292,000	565,000	"	"	Same.	Same.
11 3 20	"	4 12	17 6	74 1	57 9	270,000	568,000	"	"	"	"
11 4 20	"	4 22	18 5	73 4	59 0	268,000	562,000	"	"	"	"
11 9 20	19 Station	5 5	15 3	68 7	65 6	352,500	605,000	slight	"	Both boys stripped to waist.	Slight sweating about face.
11 10 20	"	6 18	16 5	68 8	67 4	370,000	587,000	no signs	"	Same.	" " " "
11 11 20	"	6 22	14 9	69 1	67 4	326,000	568,000	slight	"	"	H. B. appeared less energetic at start.
11 12 20	"	5 47	14 9	68 8	67 7	325,000	673,000	no signs	"	"	Slight sweating, especially about face.
11 16 20	Stope J. 20	3 36	11 35	80 6	78 4	—	441,000	slight	moderate	"	Perspiring fairly freely; slight air movement.
11 17 20	"	3 44	10 5	80 6	78 4	198,000	388,000	"	"	"	Same.
11 18 20	"	3 46	10 6	80 8	78 6	181,000	503,000	"	"	"	"
11 19 20	"	3 25	11 15	80 8	78 6	208,000	533,000	"	"	"	"
11 23 20	24 Drive W	1 38	5 05	87 5	86 7	212,500	390,000	moderate	"	"	Perspiring very freely
11 26 20	"	1 43	4 46	87 8	86 8	245,500	448,000	"	"	"	" " "
11 30 20	"	1 25	4 4	88 0	87 2	219,500	350,000	"	"	"	" " "
12 2 20	"	1 27	5 05	88 0	86 8	214,500	383,000	"	"	"	" " "
12 3 20	"	1 26	5 0	87 8	87 1	201,500	365,000	"	"	"	" " "
12 7 20	"	1 37	5 05	87 8	86 9	—	367,000	"	"	"	Rest at half-time; perspiring very freely.
12 9 20	"	1 33	5 1	88 0	87 1	—	356,000	"	"	"	Same.
12 10 20	"	1 38	4 97	87 8	86 8	—	378,000	"	"	"	"
12 11 20	"	1 36	4 95	88 0	86 8	—	374,000	"	"	"	"
12 15 20	"	2 48	9 0	86 4	85 7	—	537,000	slight	slight	"	Fan working; rest 20 minutes; half-time.
12 17 20	"	H:3 16 R:2 5	H:9 5 R:7 4	86 4	85 4	—	510,000	"	"	"	Dust samples taken; fan working; no rest.
12 21 20	19 Station	6 64	16 4	68 8	67 7	—	673,200	"	"	"	Rest at half-time; no perceptible sweating.
12 22 20	"	6 05	15 9	69 5	68 3	—	697,500	"	"	"	Same.
12 23 20	"	6 28	15 6	69 8	67 7	—	639,000	"	"	"	"

Arrangement of dates follows the American custom—*i.e.*, month, day of month, year.
[2]H B. refers to hammer boy.
[3]R.B. refers to rotary boy.

[4]These figures are abnormally low, due to insufficient weight on the rotary.
[5]These figures are abnormally low, due to the belt having been steeped in paraffin, the belt friction being so decreased as to make it incapable of sustaining more than one third of optimum weight. These figures would have been about 300,000 foot-pounds with adequate weight.

took it at first for fatigue, and consequently did not load up the machine sufficiently to test the native's capacity. Also, during the 5th, 6th and 8th of October in 24 Drive West, the output is low for a similar reason. In this case the belt, which had become tacky, was cleaned by soaking in paraffin, with the result that the friction was too small, and was incapable of supporting more than about a third of the optimum weight. When this defect was remedied, the work output rose from 201,000 to 301,500 foot-pounds, which latter figure should be taken as approximately the correct output.

On examination of Table 3, or Figure 11 which is its diagrammatic equivalent, one of the first things to strike one is the disparity of the outputs of hammer and rotary machines. It is well known that hammering, whether by engine or human power, is a very inefficient operation, there being a great absorption of energy by molecular friction in the parts giving and receiving the blow; moreover, considered from the point of view of physical energy, the action of wielding a hammer is a most inefficient one.

TABLE 4.—LOSS OF WEIGHT, AND SKIN AND MOUTH TEMPERATURES DURING TESTS

Date	Position	Cooling Power		Loss of Weight		Skin Temperature[1]		Mouth Temperature[1]	
		Dry "Kata"	Wet "Kata"	H.B.	R.B.	H.B.	R.B.	H.B.	R.B.
				lbs.	*lbs.*	*F.*	*F.*	*F.*	*F.*
Sept. 10	24 Drive W.	1.32	4.35	6.44	6.88	94.6	94.6	97.8–100.1	97.7–100.5
" 21	23 Drive E.	2.08	7.32	5.0	5.88	92.5	92.9	97.9–99.4	98.0–99.5
" 22	" " "	2.32	7.1	4.44	5.44	91.4	91.8	97.8–99.2	97.7–99.4
" 23	" " "	2.07	7.04	4.81	5.5	91.8	91.6	97.9–99.4	98.1–99.6
Oct. 5	24 Drive W.	1.65	5.56	5.5	6.19	93.6	94.6	97.5–99.6[2]	97.8–99.8
" 6	" " "	1.92	6.58	5.625	5.56[3]	94.8	93.2	97.2–99.1	97.6–99.0
" 8	" " "	1.98	6.66	5.125	4.75[4]	96.0	95.0	98.2–99.1	98.3–99.0
" 9	" " "	2.04	7.58	5.25	4.81	9[illegible].1	95.2	97.4–99.4	97.0–99.2
" 14	Stope J. 20	3.32	11.0	3.81	3.69	90.3	91.5	97.7–98.6	97.9–98.4
" 15	" " "	3.11	10.7	4.31	3.5	89.6	89.8	98.4–98.4	98.0–98.7
" 16	" " "	3.44	11.0	3.88	3.69	90.3	90.8	98.0–98.5	98.4–98.7
" 20	19 Station	4.9	14.0	2.31[5]	2.44	90.5	89.6	98.0–98.5	98.2–98.7
" 21	" "	5.1	13.7	1.44	2.0	91.0	91.7	98.2–98.3	98.0–98.4
Nov. 1	Surface	4.6	21.0	5.19	4.5	93.2	95.2	—	—
" 2	"	4.0	20.0	3.31	3.81	92.5	95.0	97.8–97.4	98.0–98.8
" 3	"	4.12	17.6	3.125	4.125	92.8	95.0	97.5–97.8	97.5–98.2
" 4	"	4.22	18.5	3.19	4.19	92.7	94.7	97.4–97.2	97.6–98.6

[1] Skin temperatures were taken on the cheek about half-time. Mouth temperatures were taken before commencing and after stopping work, the first on the surface or foot of the shaft, the last in the working place after stopping work.

[2] Mouth temperature of observer A. G. (white man) rose to 99.3° F. after two and one-half hours. On the 28th, mouth temperature of observer A. G. rose to 99.7° F. after two and one-half hours, and he lost 1 pound and 8 ounces in weight in five hours.

[3] Native attendant lost 2.81 pounds.

[4] Native attendant lost 2.44 pounds.

[5] This includes urination.

With regard to the amount of work capable of being performed, it is stated in some engineering pocket books that a man can, by winding a winch, per-

form work at the rate of 4,500 foot-pounds per minute for a period of eight hours. This refers, of course, to a hardened white laborer in the open air at sea level. On one occasion at 19 Station, the rotary boy made an average of 4,600 foot-pounds per minute, but never repeated this output. It was unfortunate that during the surface tests in June, when the weather was cold, the rotary machine was very much underloaded, consequently the output was much below the boy's normal capacity. By the time the surface tests were being repeated, the weather had become warm and an opportunity of carrying out tests on the surface with a high cooling power did not again present itself.

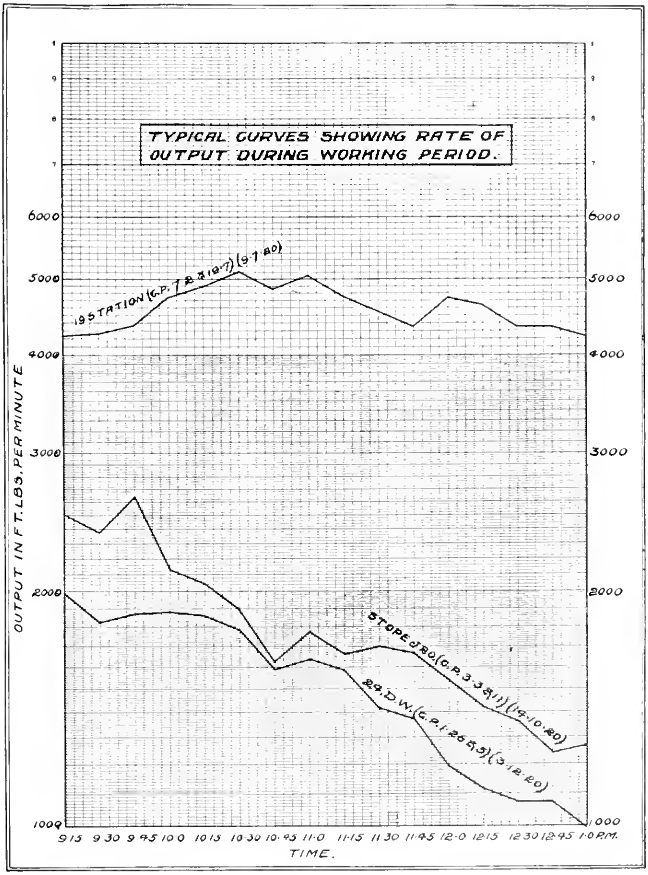

FIG. 12.—Typical curves showing rate of output during working period.

Attention is drawn to the variation of the output of the rotary machine with the atmospheric conditions. At

first, in 23 Drive East, the output was high, but after a few weeks in that place and 24 Drive West, the output fell considerably and the fatigue induced was very great. There was every sign that this was also true of the hammer machine. This was before the summer had set in. The correspondence between the rotary and hammer outputs may be judged by the fact that taking the last series of ordinary tests (November 1 to December 3) the ratio of outputs in the worst place and the best place was, in the case of the rotary machine, 0.637 to 1, and, of the hammer, 0.64 to 1.

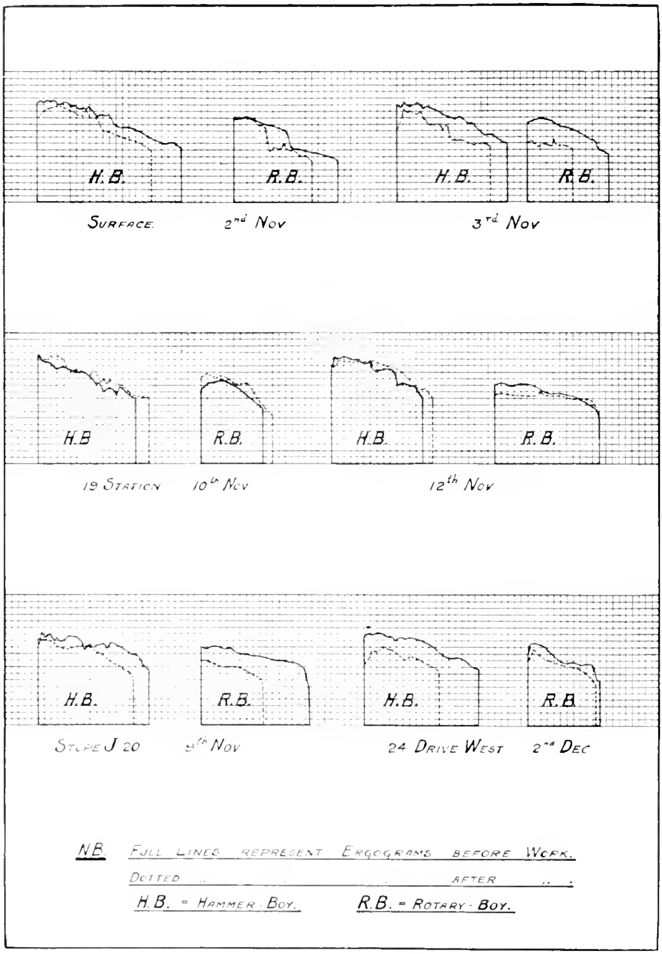

Fig. 13. Typical finger ergograms.

In the next series of tests in 24 Drive

West (November 23 to December 3) the output of the rotary machine had risen considerably, although the cooling power had fallen from its previous average; moreover, the fatigue induced was not nearly so great. It has been suggested that this may be due to practice, though increase due to practice is not shown in the output in 19 Station, either in the series of November 9 to 12 or in the last series (December 21 to 23), both of these being much lower than in the first series in 19 Station (July 6 to 9).

We think a more rational explanation is that after the weather had been hot for a considerable period the basal metabolism of the natives was notably rereduced and consequently less heat produced. Benedict[1] has found, on tests carried out on an athlete, that the basal metabolism in winter was about 12½ per cent. greater than that in summer. Another way of looking at this question is to consider that in the cold weather, for about sixteen hours of the day, the man's organism is trying to maintain heat against the heavy heat loss, then is subjected for several hours to conditions in which he has difficulty in getting rid of heat; whereas, when the weather has been hot for some time, the organism is continuously trained in heat dissipation and has much less difficulty in dealing with hot conditions. Moreover, the blood becomes more viscous in cold weather than in hot, hence when it has to be pumped rapidly round the cutaneous blood vessels in an effort to get rid of heat, the work of the heart is increased.

The decrease in output in the best place underground, *viz.*, 19 Station, from the July series to the November series may be partly accounted for by decreased cooling power and partly by the fact that the vital energy of the natives had somewhat decreased. Just after return from holiday they both seemed in splendid form and experienced very little fatigue, even after performing large amounts of work. Thus, provided there was adequate cooling power to carry off the heat produced, there was no difficulty in performing large outputs of work.

In comparing the output on the surface with that at 19 Station, the effect of altitude, which is considerable, should be borne in mind.

The effect of a period of rest of twenty minutes at half-time can be estimated better by taking the ratio of the average amounts of work done after half-time in a series of tests to the total amount of work performed during the four hours, and comparing this ratio with the corresponding ratio for a similar series without rest, rather than by comparing the actual amounts done after time in the two series, as in the latter case the condition of the subjects may have varied. Comparing the series without rest in 24 Drive West (November 23 to December 3), the ratio of work done after half-time is 43 per cent. of the whole; in the corresponding series with rest, the ratio is 41.5 per cent., so that in this case the rest shows no advantage.

In the best underground place, 19 Station, the series with rest gives a ratio of 46.3 per cent., and without rest 43.3 per cent., showing a slight advantage due to rest. The outputs of individual days are, however, so variable both in total amount and in the distribution of work over the four-hour working period that the effect of rest is not sufficiently great to swamp these variable factors.

[1] Benedict, F. G.: Factors Affecting Basal Metabolism. Jour. Biol. Chem., 1915, 20, 293.

In order to demonstrate clearly the effects of simply stirring up the air in oppressive conditions, a fan was taken down, erected and run on two days after the series of tests in 24 Drive West. The fan was a case fan, with an inlet $12\frac{1}{2}$ inches in diameter, driven by a water motor of the Pelton wheel type, consuming about 6 gallons of water per minute, with a nozzle of 5/32 of an inch in diameter and 90 pounds pressure per square inch. It was erected at the end of the drive and placed so as to blow a current of air, first over the hammer boy, who was 10 feet away from it, and then over the rotary boy, who was 7 feet further on. The air volume is estimated at 2,000 cubic feet per minute.

On the first day, a rest period of twenty minutes was taken as in the preceding series, the "kata" readings being taken midway between the hammer and rotary boys. The output is compared with the average output of the preceding series and gives an increase of 46 per cent. On the second day, no rest was taken, two sets of "kata" readings were taken, one at each working boy, the hammer boy being nearer the fan getting more cooling power than the rotary boy. The output is compared with the average of the series without rest (November 23 to December 3), and gives an increase of 32 per cent. More weight, of course, should be attached to the first comparison, as the tests followed on and were not separated by an intervening series as in the second comparison.

To ascertain whether the fan draught had the effect of raising any dust, dust samples by sugar-tube were taken: (1) before the fan was started; (2) sometime after it had started. The results were: (1) 1.2 mg. per cubic meter; (2) 0.6 mg. per cubic meter; showing that, at any rate, there was no raising of dust by the fan. Both results are very low, and the difference is within the range of experimental error, so that it cannot be taken for granted that the fan produced a smaller dust content.

The figures giving loss of weight (Table 4) are interesting, and, though somewhat variable, show much greater loss in the hot places than in the cool. The loss on the surface is much greater than in 19 Station in spite of (or perhaps on account of) the higher wet cooling power, and is more on a par with the loss in Stope J.20, where the cooling powers, both wet and dry, are lower, the former much lower. The much greater moisture evaporation from the respiratory tract will partly account for this, though the evaporation from the moist skin is also much greater in a dry atmosphere.

There is great significance in the values of skin and mouth temperatures; the former gives a very good indication of the effort to get rid of heat by radiation and convection, and it will be observed that the values are higher in atmospheres of lower cooling power. The mouth temperatures were taken as an estimate of body temperatures. Although rectal temperature is a much better indication of body temperature, it was not considered advisable to adopt this method with natives. These readings clearly indicate that in the conditions of 23 Drive East and 24 Drive West, the organism was not successful in getting rid of heat with consequent rise of temperature to an excessive degree. Readings taken in the series November 23 to December 3 showed similar rises in mouth temperature, such as 99.6°, 99.9°, 100° and 100.2°F. When we came to Stope J.20 with cooling power about 3.3 and 11, the temperature was maintained more nearly normal. In 19 Station and on the sur-

face there was little indication of rise above normal temperature.

In Figure 14 an attempt is made to correlate output of work with cooling power, due to regard being paid to accidental and unusual factors. The hammer outputs in Stope J.20 have been more or less neglected, as these are period. Neglecting the surface readings, there is a very close correspondence in the curves drawn between the wet and dry cooling power values, the corresponding wet and dry readings of underground conditions giving practically the same output of work; for instance, a dry cooling power of 4 gives 480,000 foot-

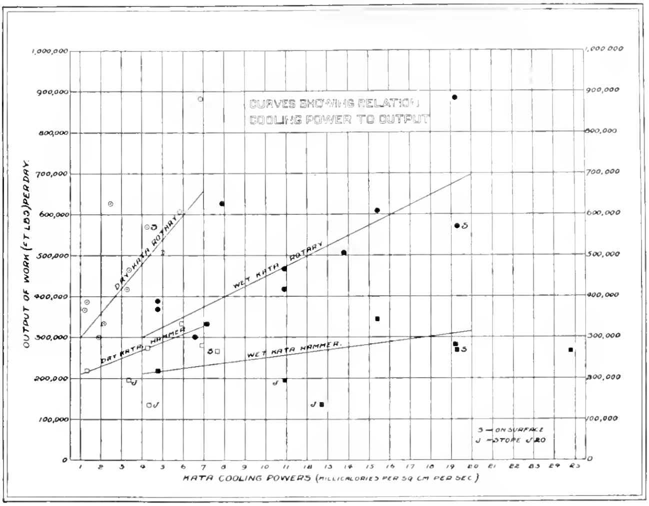

FIG. 14.—Curves showing relation of cooling power to output.

probably low, partly owing to the awkward posture of the hammer boy and partly, as was discovered later, owing to the fact that he was screened by a timber pillar from the slight air movement and had a lower cooling power than the readings give. Also the wet cooling power on the surface, though high, was not accompanied by higher output as the dry cooling power was low. The surface points are marked "S," and those for Stope J.20, "J."

As the outputs for the hammer for part of the series were not available, the rotary figures will be a much better criterion of the average for the whole test pounds output, the corresponding wet cooling power is 11, which gives approximately the same output, so that in estimating working efficiency it does not matter whether we take the dry or wet cooling power curves. It is probable that the working efficiency will increase with cooling power up to 8 dry "kata," but, not to make the conditions too rigorous, we will assume that working efficiency is 100 per cent. at dry cooling power 6. We then get a relation between efficiency and dry cooling power as follows:

Dry cooling power	1	2	3	4	5	6
Working efficiency per cent.	50	60	70	80	90	100

The curve giving the relation between cooling power and output will rise more rapidly at the low cooling powers and less rapidly as it approaches 8 dry cooling power, making a curve convex upwards. But it simplifies computation to assume that it is a straight line, and the average error in efficiency over a range of various cooling powers is small and is probably fully compensated for by lowering the standard of cooling power for 100 per cent. efficiency.

In order to form an estimate of the general loss of output incurred in a mine due to inadequate cooling power, a representative section of a mine was chosen and "kata" readings and wet and dry bulb temperatures were taken in sixty-three different positions, thirty-six of which were positions where men were working. The cooling powers, estimated working efficiency, number of men, equivalent number at full efficiency, are tabulated in Table 5, and the overall efficiency is arrived at by dividing the sum of equivalents by the sum of actual men working, thus:

$$\text{Efficiency} = \frac{215.5}{272} = 0.79, \text{ or } 79 \text{ per cent.}$$

TABLE 5.—COOLING POWER AND ESTIMATED WORKING EFFICIENCY IN DIFFERENT MINING POSITIONS

No.	Place	Cooling Power Wet	Cooling Power Dry	Working Efficiency %	No. of Natives	Equivalent at Full Efficiency
1	Incline	23.8	9.24	100.0	1	1.0
2	"	30.8	11.25	100.0	1	1.0
3	Drive	8.3	2.65	66.5	5	3.32
4	Stope	10.5	3.62	76.2	21	16.0
5	"	11.4	3.65	76.5	17	13.0
6	Drive	15.3	4.75	87.5	6	5.25
7	"	21.8	7.4	100.0	3	3.0
8	Incline	15.4	5.9	99.0	1	0.99
9	Drive	8.6	2.34	63.4	3	1.9
10	Stope	16.4	4.98	89.8	22	19.75
11	Drive	10.25	3.4	74.0	6	4.44
12	Incline	21.0	8.1	100.0	1	1.0
13	Drive	10.5	3.43	74.3	9	6.68
14	Stope	10.9	5.12	91.2	10	9.12
15	Drive	14.5	4.84	88.4	25	22.1
16	Station	16.4	6.32	100.0	1	1.0
17	Drive	7.5	2.0	60.0	3	1.8
18	Stope	11.1	3.9	79.0	15	11.85
19	Station	35.0	12.3	100.0	11	11.0
20	Drive	18.0	6.82	100.0	2	2.0
21	Stope	13.8	4.11	81.1	9	7.3
22	Drive	6.72	2.46	64.6	2	1.29
23	Incline	30.8	11.5	100.0	1	1.0
24	Winze	9.3	2.6	66.0	5	3.3
25	Winze	5.4	1.48	54.0	6	3.29
26	Incline	26.2	9.42	100.0	2	2.0
27	Raise	3.22	0.975	50.0	4	2.0
28	Incline	17.4	7.1	100.0	1	1.0
29	Drive	7.5	2.1	61.0	8	4.88
30	Incline	18.0	6.8	100.0	1	1.0
31	Drive	12.9	3.24	72.4	10	7.24
32	Drive	12.7	3.2	72.0	6	4.32
33	Incline Bottom	7.1	2.17	61.7	40	24.68
34	Drive	9.0	2.93	69.3	5	3.46
35	Crosscut	10.5	3.8	78.0	10	7.8
36	Crosscut	8.7	1.27	52.7	9	4.75
	Total				272	215.51

It is thus estimated that 21 per cent. of output is lost through inadequate cooling power. It is not implied that all this loss is avoidable loss, as it may be impossible to bring up the cooling power to the arbitrary standard, but it shows, at any rate, how important it is that adequate cooling power be maintained if at all possible. Moreover, this loss is loss of output only and does not include the losses due to the increased morbidity which must surely follow on the excessive strain and fatigue associated with work in oppressive atmospheres; such losses would be hospital charges and cost of replacing sick men.

It must be borne in mind, moreover, that the above estimate is based on tests where the native was under continual supervision and observation, where the frequent periodical reading of his output, or attention to his machine by the observer, was a constant spur to keep him working up to his capacity. In the absence of such supervision it is very doubtful whether he will keep up his best effort when fatigued. When work is going on in hot places, like "winzes" and "raises," it is observed that the white miner goes into the working place as little as possible, preferring to stay in the cooler level, with the consequence that there is every tendency to give the natives inadequate supervision.

In connection with the cooling powers taken in the representative section referred to, some were very low; in one instance dry cooling was 0.975, and wet, 3.22, while in other places the wet cooling power was 40. In many instances the working places are extremely hot and the waiting places extremely cold, the observer frequently remarking that in returning from a hot place he was severely chilled. Such extremes of cooling power cannot but have a very prejudicial effect on health and expose a man to grave danger of severe chill, not only of the respiratory membrane, thus lowering resistance to bacterial invasion and infection, but also of the general organism, thus tending to produce congestion in, let us say, the kidneys or the liver. Such dangers may have a considerable influence on the incidence of pneumonia.

It has been recognized for a considerable time that hot humid atmospheres tend to lower the resistance to tuberculosis. Pulmonary tuberculosis is more prevalent among classes of people who work in such atmospheres, and the introduction of cooler conditions underground should do much to diminish the incidence of respiratory disease and tuberculosis among the mine workers.

There has grown up recently a considerable body of informed medical and other technical opinion that even silicosis is not due to dust alone, but that the damage to the lungs is contributed to by hot, oppressive atmospheric conditions and, perhaps, by some other factors. D. Harrington of the United States Bureau of Mines, after four or five years of careful observation, seems also to have come to this conclusion. In a paper read before the Lake Superior Prevention of Accidents Conference on July 23, 1920, he says:

By far the most dangerous condition is that of breathing dusty air in a hot, humid, stagnant place all day and then going home in perspiration-saturated clothing through air frequently many degrees below zero. . . . . The effectiveness of good ventilation in preventing miners' consumption is illustrated by two mining districts in the United States. In both districts the mines have cool rock and air, dry siliceous ore, easily broken into fine dust, and the miners work hard. In one district the method of mining requires constant shooting, so the mines all have moving current of air at nearly all the working places; in the other, little or no air is circulating at working places. In the former, miners' con-

sumption is *practically unknown*, in the latter it is a *common disease* (italics ours).

Enough has been said to show the great importance of efficient ventilation at working places. The objection to the usual ventilation systems in many of the mines on the Rand is *that they fail where they are most required*, viz., *at the working places*. One reason for this is the inherent difficulty of getting an adequate flow of air from a central ventilating system through stopes, in winzes, raises and the blind ends of development drives. The cross-sectional area of the workings is very great compared with that of the shaft and drives, and a current to give adequate cooling power would require an enormous air volume to be drawn into the mine. Another reason is that *the great importance of proper ventilation is probably not thoroughly appreciated, and its bearing on efficiency is also, perhaps, not altogether common knowledge*.

It is beyond the scope of this report to go into the details of methods of ventilation which are likely to give satisfactory results, and in any case, it is probably beyond the capability of any one man to map out a complete scheme, satisfactory from the point of view of good distribution, of cooling power, dilution of poisonous gases and dust content and at the same time compatible with low first cost, low maintenance charges and convenience. Experiments with various methods would have to be made, and experience gained—practical ideas would suggest themselves as progress was made. It will not, however, be out of place to suggest some of the lines along which experiment might fruitfully be made. Good general distribution may be helped very considerably by a proper system of doors and regulators; but the best results will, no doubt, be obtained by a system of small auxiliary fans placed at strategic points, augmenting the current in the hottest places. This is done very effectively in one mine on the Rand where there is an extensive system of auxiliary fans distributing the air and blowing it into the workings, particularly the ends of development drives. In this connection, it is interesting to note that, according to the statement of the manager, the dust content in the workings is only about one-third of the general average on the Rand, and the carbon dioxide content is 0.17 per cent.

In order to get adequate cooling power in the stopes, the air current from the main circulation, or even from auxiliary branch circulations, may not be adequate, and strictly local circulation may have to be adopted. From the point of view of power cost this would, no doubt, be most economically carried out, where electric power is accessible, by portable electric fans supplied through flexible cables connected to plugs in the levels, with flexibles suspended, let us say, from hooks screwed into small fiber plugs in the hanging, the fans and flexible cables to be removed before blasting. As water at high pressure is available at the workings, another method which might be considered is to have propellor fans driven by water motors—the latter would probably have a water consumption of from 1 to 2 gallons per minute. A third suggestion which would be quite effective would be to have hand-driven portable fans, or, perhaps in suitable places, some adaptation of the "punkah." The loss of mining work of the natives driving these appliances would be much more than made up by the increased efficiency of the other workers.

The ventilation of raises, winzes and blind ends of drives has always been a

difficult problem. We suggest that a continuous circulation of air in such places should be carried on during working hours, either by power or hand-driven fans or by ejectors—whichever is the most economical—with the aid of canvas piping. By these means the temperature in the working places should be lowered to approximately that of the general circulation, and the cooling power increased to an adequate figure by the local current of air produced.

Summary of Conclusions

1. When the cooling power of the atmosphere is below 6 units by dry "kata" and, let us say, 16 by wet "kata," the working efficiency of a native (stripped to the waist) falls off. In bad places, where the cooling power is only 1.5 units (dry) and 5 (wet) or under, the average efficiency is only about 55 per cent., the body temperature rises to an undesirable degree and extreme fatigue may be produced by work.

2. Working in hot places is a greater physical strain on the worker in winter than in summer.

3. It is not advisable to put a native just back from holiday, or a new recruit, in a bad place. He will probably do better in the hot place after some training in good or moderately good places.

4. The effect of a short rest at half-time is not sufficiently pronounced to make it worth while.

5. General "kata" readings in several mines show that workers, under present conditions, may be subjected to extremes of cooling power which may severely overtax their defensive mechanism.

6. A small fan, with a capacity of about 2,000 cubic feet of air per minute, operated about 10 to 20 feet from the worker, may increase the output (under experimental conditions) by as much as 46 per cent.

7. If an average native works continuously underground at full capacity for four hours, without an unduly prolonged rest period, it is apparently all that he can do efficiently under the worst atmospheric conditions obtaining during the experiment. This time would probably be somewhat longer in those places where the conditions approximate those found in 19 Station during the winter—*i.e.*, a dry "kata" of 7 units and a wet "kata" of 19 units.

BOOK REVIEWS

Pneumonia. By *Frederick Taylor Lord*, A.B., M.D., Visiting Physician, Massachusetts General Hospital. Cloth. Pp. 69, with title pages. Cambridge and New York: Harvard University Press, 1922.

This small book is a reliable statement of the hygienic and medical position of pneumonia at the present time. It consists of the material presented at one of the Harvard Health Talks given to lay audiences during the past winter, and consequently can be utilized as a model for the presentation of the educational material to non-medical groups. Industrial physicians and nurses desiring guidance in the development of educational campaigns against respiratory infections will do well to avail themselves of Dr. Lord's text.—*Cecil K. Drinker.*

DEFINITION OF THE PHYSICIAN IN INDUSTRY.

At a recent meeting of the Conference Board of Physicians in Industry, the following definition of the *Physician in Industry* was adopted:

> The physician in industry is one who applies the principles of modern medicine and surgery to the industrial worker, sick or well, supplementing the remedial agencies of medicine by the sound application of hygiene, sanitation and accident prevention; and who, in addition, has an adequate and co-operative appreciation of the social, economic, and administrative problems and responsibilities of industry in its relation to society.

The discussion leading up to the formulation of this definition extended over several months. The question was viewed from all angles and many suggestions were considered for including in the definition an outline of what his duties and functions were.

It was felt, however, that in order to avoid a complicated statement it would be better to include in a definition only the broad fundamental principles upon which the work of the physician in industry is based, leaving to subsequent elaboration the finer details. It was pointed out that the definition adopted should emphasize both the medical attainments and the industrial requirements of the physician engaged in this work in order to make his duties clear both to the medical profession and to industrial management.

It is assumed that the physician engaged in industrial work is well grounded in the fundamentals of medicine and surgery. He is, first of all, a physician. It is obvious, however, that this alone, while equipping him for satisfactory service in private practice, does not meet fully the requirements of industrial work. In his industrial experience he has, of necessity, to deal with questions of sanitation, hygiene, and accident prevention as applied to large numbers of people working in comparatively close association. Only by special knowledge of the work in hand will the physician be able satisfactorily to discharge his duties. His knowledge of plant processes, together with the physical examination of applicants for employment and of workers already engaged, will enable him by judicious placement to reduce materially the accident and morbidity hazard and rate.

It must be realized that many of the qualifications for successful medical work in industry are of a non-medical nature, and call for a knowledge of the laws of social and industrial economics and of the administrative problems which arise in the conduct of an industrial medical department. The physician in industry must have a clear conception of the responsibilities of the industry to its workers and through them collectively to the community. On the other hand, he should recognize clearly the duties of workers to the industry in which they are engaged. It is an intelligent appreciation and consideration of these problems that make for the success of the work of the physician in industry.

It is hoped that this definition will tend to remove misconceptions as to the work of the physician in industry, and establish his position and his work upon a basis satisfactory alike to the physician and to the industrial organization.

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STUDIES ON UNDERNOURISHMENT IN INDUSTRY. I.*

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FROM time to time one sees reports of nutrition experiments which have been carried out in various public schools, and which prove beyond doubt that children will gain in weight if given extra nourishment between meals. Those who have had the opportunity of observing children on such a régime claim that there is also an increase in the ability of the child to progress in his school work, or, if you please, an increase in efficiency. The gain in weight is a fact easily proven, whereas the gain in efficiency is merely an opinion—for it cannot be accurately measured.

Believing that there is a definite relationship existing between physical par or, better, nutritive par and par efficiency, we set about to prove this in a modern factory employing 350 women, averaging 22 years in age. There are two reasons for believing that conclusions arrived at from this study will be more accurate than similar observations among schoolchildren would be: first, the factor of the growing individual is practically eliminated because of the physical maturity of the working woman; and, second, because the conditions of existence vary less from month to month—that is to say, there is less vacation, less travel, and less variety in diet among this class than is found in the life of the child of school age.

GROWTH OF THE IDEA

It may be of interest to know the manner in which the idea of making this study developed. In the early part of April, 1921, it was our privilege to hold "sick call" every noon in the dispensary of a plant employing several hundred persons, mostly girls. We were impressed by the number of workers showing evidence of malnutrition, and suggested that they be given intermediate nourishment. By way of experiment, therefore, several girls were each supplied with an 8-ounce glass of milk at 10 A.M. and at 3 P.M. After an absence of four months abroad, we were surprised, on our return, to find a very definite gain in weight among the girls who had been taking this pint of milk each day. They looked better and they volunteered the information that they were doing better work.

The result of this experiment led to the belief that, if a readily available and

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more potent nutritious substance were supplied, a greater gain in weight might be expected; consequently, it was decided to go through the factory, pick out the girls who were frankly undernourished, and give them between meals an 8-ounce glass of milk fortified by some form of carbohydrate. At the beginning of the study the undernourished were divided into three groups; to the first group Ovaltine was given, to the second group Horlick's Malted Milk, and to the last group Mellin's Food, in order to test the comparative adaptability of these three products. After several weeks it was realized that the girls who were receiving extra nourishment looked better physically and, without exception, had gained weight. The foremen of the plant, who had watched this experiment with a great deal of interest, were thoroughly convinced, long before we cared to make any definite statement, that these girls were doing better work.

In order to carry the study further, we decided to weigh every employee and take her standing height and age, and, by means of the table prepared for this purpose, to record the number of pounds overweight or underweight in each case. It was found that 42 per cent. of the women employed were underweight according to the tables by Friedenwald and Ruhräh (1). Realizing that these tables are only approximations, however, we decided to give extra nourishment to two different groups: first, to those who were at least 10 pounds under normal weight; second, to all those who returned to work after an illness or a surgical operation. It then occurred to us that it would be interesting to plot a curve of the weekly weight, and a similar curve of the efficiency record of the employees who were doing piecework. For this purpose the appended chart was used. (Fig. 1.)

Explanation of Efficiency

A word of explanation as to how these efficiency figures are obtained might not be out of place. A certain machine, for example, moves at a given rate of speed which is not too fast to permit the ordinary worker to keep it filled at all times. This means that a given number of articles should pass through the operator's hands in one hour. If the machine stops or if any other factors interfere with the proper performance of the employee, through no fault of the employee herself, this amount of time lost is subtracted and is not charged against efficiency. An operator, then, who keeps up with the speed of the machine has an efficiency of 100 per cent. If any of the products are damaged or broken by carelessness or inexactness, however, the efficiency figures are affected. In departments where there is no machine to establish the rate of production, there is a theoretical efficiency figure based on the number of products that several of the best workers can complete in an hour.

It will readily be seen that there are many factors which will influence these efficiency figures, and that comparisons of this phase of any two departments will not be accurate. On the whole, however, this basis of calculating efficiency, provided care is taken to check up each individual record, is about as accurate as one can hope for.

It is fully realized that extraneous factors influence the efficiency of employees, and will affect their ability to concentrate and to sustain continued

FIGURE 1

SUPPLEMENTARY NUTRITION RECORD

Name: Mary Smith. Department: Stem.
Indication for administration: Underweight and low efficiency.
Nourishment prescribed: Mellin's and Horlick's. A.M. 10 oz. P. M., 10 oz.
Initial weight: 114 lbs. Date nourishment started: Oct. 10, 1921.
Correct weight for age and height: 125 lbs. Peledisi % 97.
Final Peledisi % 99.

<table>
<tr><th colspan="2">Weekly Record</th><th colspan="6">Daily Nourishment Check</th></tr>
<tr><th>PERIOD</th><th>NO.</th><th>M.</th><th>T.</th><th>W.</th><th>T.</th><th>F.</th><th>S.</th></tr>
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<tr><td>" 7-11</td><td>5</td><td>||</td><td></td><td></td><td>—</td><td>—</td><td>—</td></tr>
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<tr><td>" 28-Dec. 3</td><td>8</td><td>||</td><td></td><td>||</td><td>—</td><td>||</td><td>|</td></tr>
<tr><td>Dec. 5-10</td><td>9</td><td>||</td><td>|</td><td>|</td><td>||</td><td>||</td><td>|</td></tr>
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<tr><td>" 27-31</td><td>12</td><td>—</td><td></td><td>|</td><td>||</td><td>||</td><td>|</td></tr>
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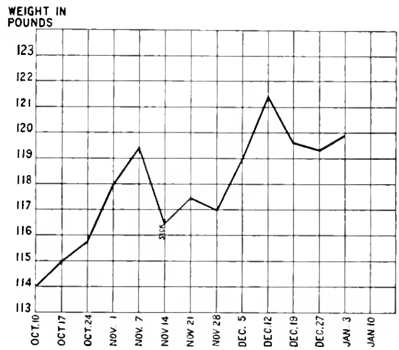


Total amount of nourishment taken: c.c., 34,800; ounces, 1,160.

EFFICIENCY RECORD

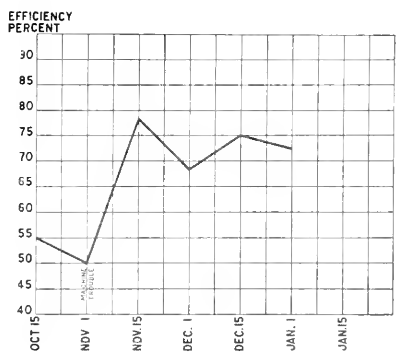
Nature of occupation: Semi-automatic.

Previous efficiency 55%

Average efficiency of dept............... 70+%

Total weight increase.................... 6 lbs.

Total efficiency increase................ 17%



application to any oft-repeated operation. Among these factors the most important seem to be sickness in the family, late hours, and pre-nuptial activities; kind and quantity of food taken at home must also be mentioned. Moreover, native ability must be considered when the efficiency of any two operators is compared. It is an undisputed fact, all things being equal, that one person will excel in a given task because of inherent aptitude, but this should not, we believe, account for differences of more than from 10 to 15 per cent.

There is yet another factor which influences production, and that is motive. For instance, a girl who is supporting her mother and small brother will try harder to have a good income than the girl who is living at home and working just for something to do.

There is a psychological stimulation which enters into any new procedure among workers, and this fact must, we believe, be taken into consideration in these observations. Each individual is told the reason why she is being given extra nourishment, and at the same time it is explained that one of the results following her gain in physical strength will be an ability to produce more. Consequently, when the weight curve begins to ascend, the employee is convinced of the success of the effort to make her better physically, and takes it for granted that she can do better work. The old adage that "nothing succeeds like success" might be appropriately quoted here, especially since there is visual evidence of success.

In compiling our results, the actual efficiency figures arrived at by the various departments are taken as they are turned in. Notations are made on each chart, explaining any factors, such as those cited in the foregoing, which influence the efficiency of the worker in question. At the present time we are not prepared to make any definite statement as to the average gain in efficiency. Further investigation is being carried on, however, and a report will be made when more accurate data are available. Meantime, it will suffice to say that in practically every case there is a decided increase in the amount of work turned out by the underweight employees to whom extra nourishment is given.

Method of Procedure

When it has been decided to give extra nourishment to an employee, every precaution is taken to eliminate disease as the cause of her malnutrition. Each employee has previously had a thorough physical examination, so that this point is not so important in our plant as in plants where physical examinations are not the rule. Nevertheless, a very thorough re-examination is made, in which such points as general appearance, color of the mucous membranes, tone of the musculature and skin are noted, and a record made of the standing and sitting height in centimeters, and of the weight in kilograms and pounds. The urine is examined, especially for sugar. The idea of the experiment is explained to each employee, and instructions are given to report to the dispensary each day at 9:30 A.M. and at 3 P.M. It is suggested that the nourishment be served from the dispensary rather than from the cafeteria, so that the procedure will seem more like a health measure than a lunch proposition, and also so that the medical staff may have an opportunity to observe the nutrition class more closely, and may be better able to suggest variations

in the kind and quantity of nourishment.

The basis of the extra nourishment is whole milk with a 3½ per cent. fat content. Unless there is some contra-indication, 10 ounces are prescribed for each feeding. To add to the food value, some form of carbohydrate is used with the milk, such as cane sugar, lactose, Mellin's Food or Horlick's Malted Milk. Ovaltine was used at first but was found to be too expensive to use in large quantities, although we believe that it has distinct merits. For patients who are constipated Mellin's Food seems to be very satisfactory, as it is slightly laxative. Three level tablespoonfuls of Malted Milk or Mellin's Food, or approximately 1 ounce, are added to each 10 ounces of milk. According to the manufacturer's directions, Mellin's Food should be mixed at least two hours before serving in order that the curd will be softened. Both Horlick's Malted Milk and Mellin's Food are more easily taken over a long period of time if they are slightly flavored with chocolate. Various other combinations, including a mixture of the two foods, have been prepared by our plant nurse, and have had a very satisfactory taste. Cane sugar and lactose do not, for the most part, seem to be as suitable as the dextromaltoses.

The food value supplied by the above mixture is approximately 300 calories per glass or, calculated by Pirquet's table, 480 *nems* (the nem being the food value of 1 c.c. of milk). This means that those fortunate enough to be placed on the nutrition squad are given about one-fourth of their daily food requirement. The cost of such mixtures, based on milk at 30 cents per gallon, is 5 1/3 cents per glass.

Ninety per cent. of the nutrition class take one of the mixtures, which we have mentioned, without discomfort. Occasionally there is a complaint of digestive disturbance, but this is usually rectified by reducing the quantity, changing the food, or cutting down the amount of carbohydrate or fat. In some instances the intermediate feeding interferes with the regular meal; in these cases the food can be taken with the meal and at night before retiring if the individual is willing to buy it for herself. (This has been done with good results in several cases.)

Our first charts were prepared to cover a twelve-week period, and this seems to have been a fairly good estimate, as most of the workers have made satisfactory gains in that time, and some have reached normal weight in even less time.

Reference has been made to the fact that in the beginning of our study we recorded each employee's weight in kilograms and her sitting height in centimeters. These figures are obtained in order that the system of nutrition devised by Pirquet may be used. The percentage nutrition, or *peledisi*, as expressed in his tables, seems to us to be the most satisfactory way of approaching the question of what constitutes normal, when speaking of nutritional standards. Unfortunately, the tables published in this country are complete only to include a sitting height of 90 centimeters. Comparisons between this and other systems are now being made. Complete *peledisi* tables have just reached us from Vienna, including sitting heights up to 100 cm.[1]

[1] Our request for complete tables was answered very generously by Dr. Schick of the Kinderklinik in Vienna, and we have a few extra copies which we will gladly send to anyone desiring them.

Because of the variation in the amount of breast tissue among women, we have not used the sitting height bust measure as an index of nutrition in our cases.

Suggestions

To those who study the weight curves of employees taking extra nourishment, there will come some disappointments at the beginning. In a few instances the weight curve falls, but it rises again in 98 per cent. of the cases, and keeps rising as long as sufficient intermediate feeding is given.

To insure success, the administration of the nourishment should be under the direct supervision of a nurse who is interested and who does not feel that it is a burdensome duty.

Provide the nourishment free of charge for at least twelve weeks; then, if the employee so desires and if it is thought best to do so, permit her to pay for it.

Explain the proposition to the foremen and ask their co-operation in selecting persons who would possibly be benefited. Suggest that they send to you employees doing noticeably poor work. This will afford an opportunity to detect incipient diseases. It has been found to be of distinct value in instituting preventive measures, which are timely not only from the standpoint of the individual but also from the standpoint of her associates.

Much has been written about relaxation and short exercise periods during work hours. The plan of having employees report to the dispensary rather than having the nourishment served to them at their machines is in keeping with this idea.

The food recommended is of high carbohydrate value. As a matter of safety, therefore, the urine should be examined to exclude the possibility of glycosuria before the procedure is begun.

Results

Since August 15, 1921, records have been kept of seventy-five employees to whom extra nourishment has been given, gratis. They may be grouped as follows: 33 active cases; 11 short period cases; 31 completed cases. The active cases include new employees who are underweight, old employees who are losing weight, and those who are convalescing from illness or operation. It will readily be seen that this is a constantly changing list.

The most satisfactory results have been noted in the group last mentioned, the convalescents. There is a steady gain in weight among the members of this group, and we feel that the return to normal health is much more rapid than when no extra nourishment is given. Moreover, in this group will be found the most appreciative patients. Their loyalty to the institution is greatly enhanced as a result of the interest in their welfare shown by the medical department. The short period group consists of those who, for any reason, stopped taking the nourishment before two weeks had passed. In this group are included those who were laid off work, two employees who had digestive disturbance, and several who were not interested enough in their own welfare to climb two or three flights of stairs to get their nourishment. The completed case group includes all those who received the nourishment for four weeks or more.

Up to the present time one-half of our diet squad have been time workers

and of course no efficiency figure is available on this group. The final result in this instance is arrived at by noting the increase in weight, the comparison of the physical condition with the record kept on the back of the chart (that is, general appearance, color, muscular tone, condition of skin), and, in addition, the statement of the patient herself. In 90 per cent. of the cases the patients have stated that their general health is improved, that they are feeling better, and that they have lost less time on account of illness than ever before.

The greatest gain in weight recorded was 12 pounds in twelve weeks. The average weight increase was 5 pounds for those who had been in the squad for more than four weeks. Two girls lost slightly in weight but gained in efficiency. The weight curve is a very sensitive one, being influenced by many factors. Slight colds, minor injuries, sickness of some member of the family, and insufficient sleep, all have a decided tendency to cause loss of weight.

In the group for which efficiency figures were available, twenty-two gained in production, seven showed no change, and five lost. In two instances the gain in efficiency was such that it made the worker the best in her department.

An interesting finding has come to light in the study of the influence of this régime on hourly production. An endeavor was made to find that peak of efficiency followed by the "fag" period, about which one reads so much. It was hoped that proof could be offered to substantiate the statements that energy provided in the readily assimilable milk and dextrose mixture would tide the worker over this period, but no such falling curve can be plotted of the production in this establishment. It was surprising to find that the number of products turned out by a given worker during the second hour of the work period in nearly every instance represented the number which obtained in all successive hours of the day. This is explained by Dr. Lee[2] as follows: "Where work is monotonous and where it is frequently broken by natural pauses, a curve may be obtained which for both working spells is nearly a straight and horizontal line, showing a slight practice effect but no fatigue." A similar curve can be constructed of the hourly production in our plant.

The energy provided by the extra nourishment seems to increase efficiency by benefiting the general health of the recipient and not by any temporary effect such as would tide the individual doing heavy, prolonged muscular work over a period of exhaustion.

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GERMAN LITERATURE ON THE WHITE LEAD QUESTION, 1921*

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THE decision of the Washington Conference (November, 1919) that the question of the prohibition of the use of white lead in painting should be placed on the agenda of the next International Labour Conference, now (October, 1921) meeting in Geneva, provoked a heightened interest in the subject in all countries—in Germany as well as elsewhere. There follows a short summary of the German literature which has appeared on the subject.

Schoenfeld (1) sees in the blood changes, especially in the basophilic granulations, a reliable aid in recognizing the first stages of lead poisoning. He examined the blood of numerous workmen who had been reported to the Leipzig Sickness Insurance Office as lead poisoned, and was able by this means to determine that, in a large percentage of the workmen, the diagnosis of plumbism was incorrect. Of those incapacitated supposedly on account of lead poisoning, only 9 per cent. of the compositors, 38 per cent. of the painters, and 90 per cent. of the workers in ceramic color printing showed characteristic blood changes. Since the verification of the diagnosis of lead poisoning in the Sickness Insurance Office has been made dependent upon blood examination, the number of cases of lead poisoning has considerably decreased. That the number of demonstrable cases of lead poisoning has been increased through the elimination of cases incorrectly diagnosed, is undoubtedly true. I doubt, however, whether the figures are correct even as they now stand, inasmuch as Schoenfeld overlooks the fact that among those either not reported, or reported sick under some other diagnosis, there must be some persons suffering from lead poisoning. Contrary to the statements of Schoenfeld, Böttrich (2) emphasizes the importance of purely clinical symptoms—*i. e.*, lead line and lead pallor.

Schwarz has published two articles on blood examination in lead poisoning suspects (3) (4), in the first of which he discusses the technic of the thick drop method. This is easily carried out during the examination of large groups of persons as it does not require careful cleaning of the slide; furthermore, it simplifies the finding of basophil-granular red cells or their remains. After the remains of polychromatic or basophil-granular red cells have been found, then, in order to count the relative proportion of these cells, ordinary blood smears are prepared. With practice it is possible to estimate with some precision whether cells with basophil granulations are present in greater number than in normal blood. Schwarz was able, by this method, to stain and examine the preparations from fifty-one painters in three and one-half hours. Two observers looked over ten fields in each preparation and classified them as doubtful, positive, or negative. Then smears

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were prepared by other observers and 200 fields on each slide were examined—a procedure which required about three and one-half working days The results of both methods were in agreement. Without doubt when this method becomes established, the examination of large groups of persons will be considerably simplified; indeed, it may be that not until then will mass examinations become possible.

Süssman (5), working in Lehmann's Institute in Würzburg, made a series of extremely careful experiments on skin absorption in cats and guinea-pigs. The absorbed lead or mercury was demonstrated by the study of carefully collected urine and feces. An attempt at self-experimentation failed, owing to the fact that specimens of stool obtained before the beginning of the experiment contained lead. In spite of the extreme accuracy and conscientiousness with which the animal experimentation was conducted, the conclusions drawn by the author do not seem well founded. That there is no essential difference in absorptive power between the skin of man and the nearly sweat-glandless skin of cats has not been shown beyond reasonable doubt by Süssmann's self-experiment; nor can his estimate, that in therapeutic inunction only a third of the absorbed mercury finds its way through the skin, stand as proven. One must, however, agree with the author that his experiments seem to show the amount of lead absorbed through the skin to be so small (0.1-0.2 mg. of lead per square decimeter of skin as a daily average) that the possibility of industrial lead poisoning through skin absorption must be denied. I should like to add that exception must be made in the case of actors, dancers, etc., since it is to be expected from these experiments that where large surfaces of skin are covered with lead ointments, used as make-up, there may easily be enough skin absorption to produce poisoning.

Of the writings growing out of the controversy in regard to the prohibition of white lead may be mentioned first the reply of the Association of German White Lead Manufacturers of Cologne (6) to the memorandum of the International Labour Office, containing a supplement in which are given evidence and testimony. The "Reply," a polemic against the pamphlet of the International Labour Office, maintains that white lead is irreplaceable for painting purposes, and that the prohibition of its use for painting would undoubtedly be the first step toward *universal* prohibition of all lead colors. It stresses the indispensability of white lead, litharge, and minium for various industrial purposes; further, it attacks the correctness of published statistics in regard to the frequency of lead poisoning by referring to the investigations of Schoenfeld; and, finally, it calls attention to the economic damage that would result to Germany from the prohibition of the use of lead colors. In the supplement, various Associations of Master Painters express their opinions as to the impossibility of replacing white lead in outside work. A number of shipyards and iron construction companies emphasize the necessity of employing lead colors, as do a number of other industrial establishments, such as rubber factories, glass makers, linoleum factories, electric works, potteries—in short, a long list of industries in which no one thinks of forbidding the use of either white or red lead. Characteris-

tic of the preparation of the pamphlet is the inclusion of the protest of a large part of the employees in white lead works against the "prohibition of the manufacture of white lead."

The Düsseldorf Chamber of Commerce (7) also takes its stand against the proposed prohibition of white lead in a memorandum on "The Use of White Lead in the Painting and Decorating Trades." This memorandum gives a short summary of the present-day status of legislation. It is the opinion of the Chamber of Commerce that in interior work, at least as a covering paint, white lead is unquestionably replaceable, but that in outside work it is indispensable. Even with the high price of linseed oil and although zinc white requires more linseed oil than does white lead, the cost of a single coat per square meter is considerably higher with white lead than with zinc; nevertheless, on account of its alleged poorer covering power, more coats of zinc white are required, and the cost of the completed job with zinc white is consequently somewhat higher than with lead. Furthermore, the zinc coating has to be renewed in a short time. The article quotes the statistics of lead poisoning in Berlin and Hamburg in the pre-war period, and challenges their correctness on the basis of Schoenfeld's investigations. It mentions the economic consequences of the prohibition of lead colors, and maintains that lead smelters are dependent for the disposal of their product on the lead color manufacturers who utilize about one third of the output; and that if lead color manufacturers should be driven out of business, other industries employing lead compounds would be similarly affected (?).

Another pamphlet on the same subject (8) published by the Union of German Painters, Varnishers, etc., shows how the Union, the Social Democratic Guild of Painters, has for the last twenty years been leading the fight against lead colors, and presents a series of data in regard to sickness in the painters' trade (rheumatism, eczema, tuberculosis, nephritis), taken from the writings of Koelsch (9) (10). Then follow details of lead poisoning and its symptoms. The prohibition of dry sand papering contained in the present regulation is declared to be impracticable, since wet rubbing down, the process to be substituted, is impossible for technical reasons which are outlined, as well as on account of the cost. Dry sand papering is thus technically necessary and economically justifiable. During this process, however, inhalation of dust is unavoidable, since respirators and wet sponges are too great a hindrance to breathing. Replacement of lead for indoor work is unquestionably possible. While it is true that outdoor work with lithopone often becomes more quickly damaged, this is due to inexpert workmanship. With intelligent use, zinc white and lithopone can readily replace white lead even in exterior work.

The same guild also published a thirty-eight-page lecture which was delivered at its General Assembly in July, 1921, by Dr. Koelsch, the Bavarian State Industrial Physician, entitled "Harmful Effects of Lead in the Painting and Varnishing Trades from the Point of View of Physician and of Legislator" (11). Koelsch discusses the kinds of lead colors, the modes of entrance of lead into the body—namely, the inhalation of lead dust and the direct conveying of lead to the mouth by the hands—and the rôle of personal

susceptibility, and then presents copious statistical material in regard to the frequency of poisoning in different localities. He also gives a résumé of the regulations which have been issued for the protection of painters in Germany, discusses their value, and concludes that the present statute with its prohibition of dry sand papering and its provision for cleanliness has not led to any far-reaching improvement of health conditions. He points out the success which followed the prohibition of the use of lead colors in indoor work in Austria, and mentions investigations in regard to the merits of lead-free and lead-containing pigments which have been carried out by various official departments in Holland, Denmark and France. Finally, he demands the prohibition of the use of white lead for indoor work with certain extensions (carriages, automobiles, garden furniture, machines), and also recommends obligatory declaration of contents. It is his opinion that lead-containing paints should be sold and used only with the label *Lead-Containing—Poisonous.* Medical supervision of decorators and painters using lead paints should occur at intervals of two or three months. Technical justification for the prohibition of the use of lead colors for exterior work does not seem to Koelsch to be sufficiently established as yet.

Teleky (12), in his article on "The Use of Lead Colors in Painting, the Danger and Its Prevention," attempts an objective presentation of the question. He points out, first of all, to those who see in the international prohibition of white lead a hostile action directed against Germany, that the Geneva International Labour Office of the League of Nations is only continuing the work begun under German leadership by the International Union for the Legal Protection of Workers in Basel. He shows that, although Schoenfeld may be right in saying that in many trades, especially printing, too many cases have been wrongly diagnosed lead poisoning, on the other hand, many cases of lead poisoning have been unrecognized; and that at all events the number of cases of poisoning among painters is distinctly high. The decline of this number during and after the War must be laid to a lack of lead colors and to the depression in building activity. Since lead poisoning results chiefly from the inhalation of lead dust, workers in interior painting for the most part become sick as a direct result of the necessary dry rubbing down. On account of the fact that house painters are constantly changing their work places, it is impossible to carry out and supervise effectively any protective measures that may be prescribed. The writer knows this from his experience in Vienna; but in addition statistics show that in Vienna, where the use of white lead in interior decoration is prohibited, the incidence of lead poisoning in painters has fallen to one-third; whereas in Berlin, where other protective measures only (without prohibition) are in force, after falling to one-half, the incidence rose again to its former height. With regard to the technical possibilities Teleky finds support in the evidence gathered by the Dutch Royal Commission. He points out that, since Germany produces much less lead than its industrial needs demand, considerable quantities of lead must be imported; and that economic harm to the country, as maintained in the statement of the white lead manufacturers,

would not result, since the zinc color industry in Germany is very highly developed and shows a constantly increasing export. Teleky considers the prohibition of lead colors for indoor work (extended to window frames, garden furniture, carriage and automobile enamel) to be absolutely essential, and technically possible to carry out; he considers equally necessary the prohibition in all kinds of painting of the use of red lead, which is unfortunately often forgotten in the discussion; and, in addition, compulsory declaration of contents. Even in exterior painting, prohibition of white lead is necessary in spite of the technical difficulties of finding suitable substitutes.

Teleky's articles gave Schoenfeld opportunity to write "An Answer and Justification" (13) in which he maintains his point of view. In a further work, "The Impending Prohibition of White Lead and Methods of Blood Examination as a Prophylactic Measure" (14), he explains his opinions in detail. New is the fact that in addition to the granular red cells he attributes great importance to the polychromatophilia. He attaches no value to the number of basophil erythrocytes and sees in their presence (no matter in what number) not the signs of lead *poisoning*, but rather merely the signs of lead *effect*. He demands, therefore, not that the workmen with positive blood findings be kept from lead work, but merely that they be placed under especially careful supervision. From this point of view, it seems, the demonstration of granular cells has lost a great deal of its practical value.

In a short article on "The Use of Lead Colors in the Painting Trade" (15), Teleky replies to the new statements of Schoenfeld. He points out that up to the present time prescribed periodic medical examination has not obtained the desired result in many factories. The white lead industry itself, which now finds the methods of Schoenfeld so promising, has already had enough opportunity to demonstrate that by means of regular medical supervision and examination all dangers can be avoided. But the proof of this is still lacking.

In the meantime the closing of the Geneva Conference has put at least a temporary end to this discussion. In spite of the recommendations of the special commission, the main assembly very justly voted in favor of the prohibition of the use of white lead in interior painting—a prohibition which, unfortunately, is weakened by a number of exceptions and by an all too long delay in its introduction. In the meetings of the committee there was one unpleasant circumstance, in which the Geneva Session of the League of Nations differed from former international conferences called by the International Association for Labor Legislation, and this difference was by no means to the credit of the Geneva Conference. In the conference of the International Association the governments of the various countries were represented as well as workmen and employers, but the body of the Assembly was composed of sociologists, of experts in the field of social legislation, and the sub-committees of experts in their corresponding fields. In Geneva, however, it was primarily the representatives of governments, employers and employees who had the floor. Experts were present only in so far as they were brought by one of these groups. Hence the following situation resulted: In so far as scientific experts (doctors,

national economists, sociologists) were necessary, the employers selected those experts in their countries who represented most nearly their point of view and brought them to Geneva at their own expense (for countries with depreciated currency the cost of this trip was a large item). The labor representatives did the same, but expense was a far more serious item for them than for the employers, and consequently they were obliged in great part to forego the service of experts. The governments, which had for the most part already stated their stand in the matter, likewise secured for themselves experts who shared their opinions. On this account the conference, instead of consisting of those experts from various countries who had occupied themselves most intensely with the question under discussion (as was the case in the previous labor conferences), was rather made up of those who seemed to the various parties best suited to represent their partisan opinion. And the workers' viewpoint, on account of the great expense, was far too poorly represented. The white lead committee consisted of nine "experts" for the governments, eleven for the employers, and four for the workmen, with no doctor among them. In this respect it would seem that the whole organization of these conferences is susceptible to improvement.

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BACK AND FOOT STRAIN*

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BACK strain and foot strain are loose but convenient terms under which may be grouped a large variety of rather ill-defined and little understood conditions. Collectively, they are responsible for a high percentage of disability among employees, and the duration of the affection and ultimate result are always matters shrouded in mystery. The questions of treatment and prevention which constitute the real problem of the industrial surgeon are wholly dependent upon the recognition of the underlying causes, and for this a thorough understanding of the anatomy and physiology of the region is necessary.

BACK STRAIN

Anatomy of the Spine.—The vertebrae are composed of two parts, the body, or weight-bearing portion, and the spinal arch with its accessory processes, the function of which is to protect the spinal cord and provide attachment for muscles and ligaments.

The bodies articulate with each other by means of the intervertebral disks which have resistant semi-fluid centers but elastic, compressible peripheral layers, so that rocking motion or rotation in any direction is permitted. The spinal arches are joined by articular processes projecting upward and downward in pairs from each vertebra. The joints so formed are true joints, lined with cartilage and surrounded by capsule. The shape of these articular processes varies, however, in different segments of the spine, and as their function is to limit the motion of the vertebrae, it will be seen that the type of motion permitted at different levels is directly related to the shape of the process.

In the dorsal region the articular processes are vertical and flat and face in the anteroposterior plane, thus permitting flexion and extension, lateral bending and rotation. At the same time each of the vertebrae in this region supports a pair of ribs and the relation of the latter to the thorax results in considerable secondary limitation of motion, chiefly affecting flexion and lateral bending. In the lumbar region the articular processes are normally crescentic in cross section, and vertical. This shape limits rotation but permits free flexion and extension and lateral bending.

The vertebrae are bound together by strong anterior and posterior common ligaments extending from the sacrum to the occiput, covering the bodies and the disks. The ligamenta subflava are strong elastic ligaments which run along the posterior surface of the spinal canal and are attached to the laminae. The interspinous and intertransversalis ligaments join the spinous and transverse processes, respectively. Motions in the anteroposterior and transverse planes are checked by the tension of the ligaments on the sides of the bodies opposite to the direction of the movement, and also by the resistance to com-

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pression of that edge of the intervertebral disk toward which the motion occurs.

While the extensive range of motion of the whole spine is the resultant of many slight movements between the individual vertebrae, the greatest degree of movement occurs at the points of junction between the fixed and unfixed portions as represented by the dorsolumbar and lumbosacral articulations.

The lumbosacral articulation presents certain peculiarities not found in the other spinal joints. The body of the fifth lumbar is higher in front than behind, and the disk between it and the sacrum is of greater thickness than the other intervertebral disks, especially in the anterior portion. In addition to being supported by the common spinal ligaments, this joint is reinforced by strong fibrous bands extending from the transverse processes of the fifth lumbar laterally to the iliac crest and downward to the sacrum, the iliolumbar and lumbosacral ligaments, respectively.

The sacrum is formed by the fusion of five vertebrae, of which the upper three serve to support the pelvis laterally, by entering into the formation of the sacro-iliac articulations. These are true joints, lined with articular cartilage and containing synovial cavities. The sacrum is broader in front than behind, so that on cross section the joint line is oblique, running backward and inward, as shown in Figure 1. The surfaces are gently irregular, tending slightly to interlock. They are held together by the anterior, superior, and posterior ligaments. The posterior ligament is by far the strongest, as its function is to sling the sacrum and resist the tendency of the body weight in the upright position to force the sacrum forward into the pelvis. It comprises many layers of strong fibers filling the gutter-like space between the projecting posterior edge of the ilium and the surface of the sacrum. The normal motion at the sacro-iliac joints is slight and consists of rotation of the sacrum on a transverse axis passing through the second segment. Normally the anteroposterior diameter of the brim of the pelvis may be increased or lessened about 1 cm. by the extremes of this movement.

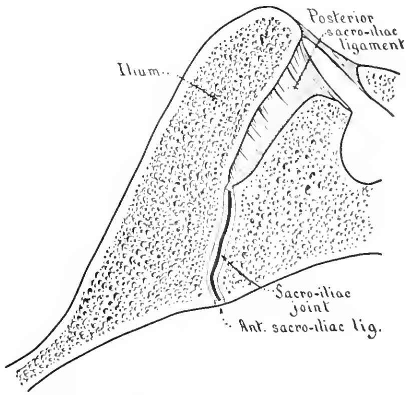

Fig. 1.—Cross section through the sacro-iliac joint. Note its sloping direction backward and inward.

The spine is supported and held erect by the balanced action of the various trunk muscles. The chief flexors are the recti abdominis and the psoas. The extensor muscles comprise the large muscular mass occupying the fossae formed by the transverse processes anteriorly and the spinous processes mesially, and are composed of the erector spinae, transversospinal and intervertebral groups of muscles. Lateral support is given by the quadratus lumborum and the external and internal oblique muscles.

The manner in which the spinal

nerves make their exit from the spinal canal through the intervertebral foramina and their close relation to the vertebrae and the spinal joints expose them to pressure and injury in conditions affecting the spine. The intercostal nerves may be involved in lesions of the dorsal spine with resulting intercostal neuralgia. By localizing the affected nerve the level of the spinal lesion may be determined.

In the lumbar and sacral regions the nerves join to form the lumbar and sacral plexuses. The lumbar plexus lies in the substance of the psoas muscle and is formed by the first, second, and third lumbar roots with branches from the twelfth dorsal and fourth lumbar roots. It gives origin to several nerves, among them the anterior crural and obturator nerves. Pain referred along the anterior or inner sides of the thigh or wasting of the quadriceps muscles, therefore, indicates a lesion in the upper lumbar region. The sacral plexus is formed by the junction of the first, second, and third sacral roots with the lumbosacral cord which contains all the fibers of the fifth lumbar and a branch from the fourth lumbar root. From it is given off the sciatic nerve. Parts of the plexus lie in close relation to the lumbosacral and sacro-iliac joints, and sciatic pain or muscular or cutaneous disturbances in the sciatic distribution in association with affections of the spine localizes the lesion at the pelvic joints.

The spine normally presents four curves which, in relation to the ventral surface, consist of a cervical convexity, a dorsal concavity, a lumbar convexity, and a sacrococcygeal concavity (Fig. 2). The dorsal and pelvic curves may be considered as primary curves, as these segments form parts of the pelvis and thorax and are comparatively rigid

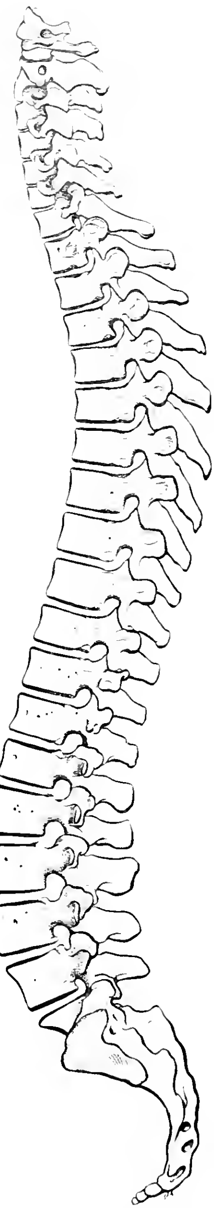

Fig. 2.—Lateral view of spine, showing articulations and normal curves.

portions although, as has been seen in studying the spinal movements, these curves are capable of considerable modification by flexion, extension, and lateral bending. The lumbar and cervical regions are the flexible connecting links and the chief balancing agents because they possess the greatest degree of movement. The cervical curve appears when the child begins to hold the head upright; the lumbar curve develops only when the vertical position is first assumed. They are, therefore, secondary curves intended to compensate for the normal inclination of the pelvis and the posterior convexity of the dorsal region.

Etiology of Back Strain.—The key to the entire problem of back strain lies in the proper understanding of the normal physiology of the spine. A perpendicular dropped from the occipitospinal articulation normally crosses the spine in the upper cervical, cervicodorsal, dorsolumbar, and lumbosacral regions. The cervical and lumbar curves project in front of the line, while the dorsal and sacral curves project behind the line. The balancing relation is so accurate that no one curve can be increased without corresponding increase of the others and, conversely, no one curve can be decreased without accompanying flattening of the entire spine.

With every movement of the body the center of gravity shifts, and compensatory change of the spinal curves in one or the other direction must occur in order to maintain balance. In the normal erect posture all of these curves are slight, and none of the spinal joints is used at its limit of motion. Balance may, therefore, be easily maintained. Moreover, the load is evenly distributed to all of the supporting muscles so that there is no excessive fatigue. The muscles can retain their normal tonicity, and the ligaments are protected from strain.

With incorrect habits of posture, however, the conditions are quite reversed. When the spine sags, its curves become exaggerated and the spinal joints are used at their extreme limit of motion. There is extreme hyperextension of the lumbar spine, increased flexion of the dorsal region, and also increased inclination of the pelvis. The ligaments which normally check extreme ranges of motion are constantly under tension. The normal balancing mechanism is lost because compensatory movements of the vertebrae can take place in but one direction. Movement in the other direction can occur only at the expense of the structures normally checking motion, with resulting strain and injury. Moreover, the muscles no longer carry their fair share of the burden of the body weight. Certain muscle groups atrophy as a result of disuse, and the load is borne by the ligamentous and bony supports. Other groups are overworked, become fatigued, and lose their normal tone. A vicious circle is thus formed because, with gradual weakening of the muscles, sagging occurs more and more, and this of itself results in still further weakening of the muscles.

The points in the spine which are most exposed to strain are the lumbosacral, sacro-iliac, and dorsolumbar articulations, because they represent junction points between fixed and flexible portions of the spine. In the incorrect position the sacrum is more horizontally placed than it normally is, so that the sacro-iliac joints derive less support from the shape of the bones. The sacrum is left hanging by its posterior ligaments, with the result that they may become relaxed and strained. The position of extreme hyperextension

of the lumbosacral joint causes the articular processes of the fifth lumbar to slide down until they rest against the sacrum, and painful bursae may develop beneath them. The body weight is transmitted to the sacrum by way of the spinal arch instead of by way of the vertebral body. The intervertebral foramina are narrowed, and nerve root compression may occur. The iliolumbar, lumbosacral, and all other ligaments supporting the joint are strained

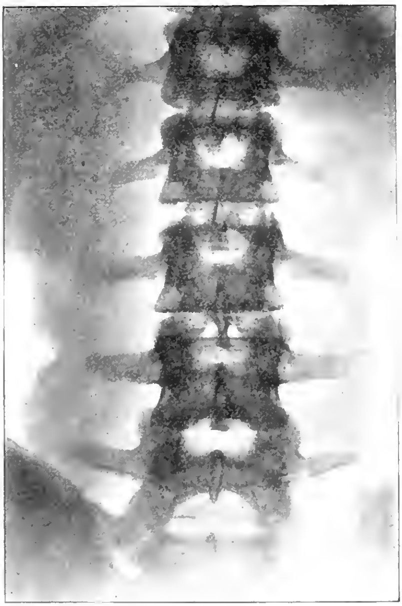

Fig. 3. Lumbar spine. Slender type. The bodies of the vertebrae are square, the sacrum extends well upward, and the transverse processes of the fifth lumbar are well removed from the ilium.

and injured. Conditions are similar at the dorsolumbar junction, with resulting ligamentous strain, and in addition the last rib may be approximated to the transverse process of the first lumbar vertebra, thus making possible compression of the intercostal nerve.

Anatomic Variations of the Spine.—Variations from the normal or textbook anatomy are very common in the spine and, by lessening the stability of certain joints, may become factors in the production of strain. This variation may be one of number, shape, or development. Numerical variation, such as the presence of extra lumbar vertebrae, occurs frequently and gives rise to many interesting speculations, but is not an apparent factor in the production of strain.

Variation in shape is a frequent occurrence in the dorsolumbar and lumbosacral regions. In the former, the differences have chiefly to do with the development of the last ribs. They may be so small as to be barely visible, or again they may be quite long. There is also corresponding variation in the transverse processes of the first lumbar vertebra, and the relative development of these two processes may be important in determining the possibility of nerve compression when the body sags. In the case of the fifth lumbar, the transverse processes may show great variation. They may be long and slender, or heavy and fin shaped. They may be in contact with the top of the sacrum or the wings of the ilium, and may form true joints with either or both of them. In this case the stability of the lumbosacral articulation is increased, and the chief strain falls at the junction of the fourth and fifth lumbar vertebrae. Frequently, however, this over-development is one-sided only, and then it is easy to understand that an element of cross strain is brought to bear on the unsupported side and that this strain may affect not only the lumbosacral region but the sacro-iliac ligaments as well. (See Figs. 3, 4, 5 and 6.)

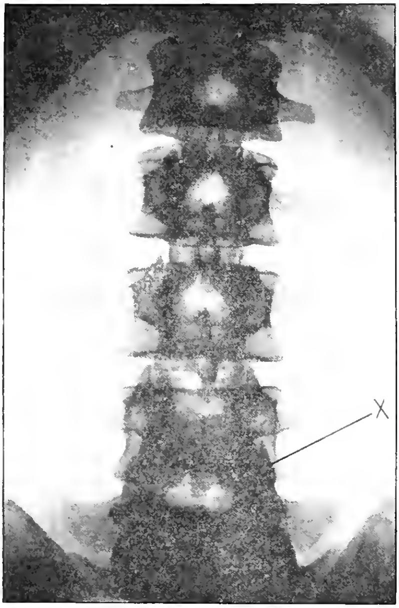

FIG. 4.—Lumbar spine. Heavy type. The width of the bodies is greater than their height, and the transverse processes, particularly those of the fifth lumbar, are broad, but not in contact with the ilium. The crescentic shape of the articular processes is well shown at X.

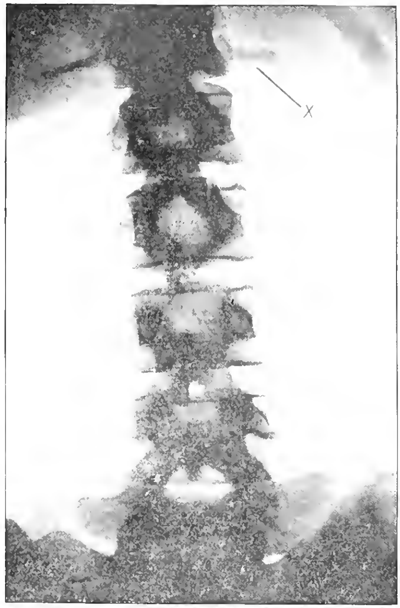

FIG. 5—Lumbar spine. Mixed type. The upper four lumbar vertebrae are of the slender type with small transverse processes, while the fifth lumbar is distinctly broad with large transverse processes, one of which articulates with the side of the ilium and the top of the sacrum. What appears to be the first lumbar is really the last dorsal, there being an articulation for the costal element visible at X.

Variation in the shape of the articular facets at the lumbosacral region is also common. (See Fig. 7.) They may be quite flat and may look forward and backward instead of facing in two directions, or one may be flat and the other crescentic. The flat articulation gives stability in only one plane, allows greater motion, and is less well adapted to resist strain than is the normal crescentic process. An asymmetrical variation is essentially a poor mechanical arrangement and likely to give out under the influence of heavy work. Other variations frequently seen, which may also have an influence on back strain, are those due to developmental defects. These include incomplete closure of the spinal arches, or spina bifida occulta, usually involving the last lumbar and upper sacral vertebrae (Fig. 8), imperfect development of the body of the fifth lumbar, and twisting of the spinous processes from excessive crowding together during the formative period of life.

Diagnosis.—The differentiation of the various types of back strain is always difficult and can only be made after elimination of all other types of bone and joint pathology, such as tuberculosis, syphilis, arthritis, and neoplasm. A complete investigation of the pa-

tient's history and a thorough examination with the body uncovered are essential. The chief points to be noted on examination are the general attitude and body contour, the position of the spine when standing, presence or absence of listing, restricted and painful movements of the spine and hips, limitation of flexion of the hip with the knee extended, spasm of the erector spinae muscles, and points of tenderness on pressure over the pelvic joints or spine. The length of the legs should be compared by accurate measurements, as should also the circumference of the thighs and legs. Nerve function should be carefully determined by testing the reflexes, cutaneous sensibility, and voluntary muscle power. Last, but by no means least, the examination should include rectal examination, abdominal palpation, urinalysis, and blood-pressure readings, in order to eliminate extraspinal causes of back pain.

Roentgenographic examination is of distinct help not only in eliminating other bone and joint lesions but because of the information which may be gained as to the general structure of the spine and the presence or absence of anatomic variations. The effect of strain is often seen in the calcification of ligaments, especially the iliolumbar, or in the development of small hypertrophic spurs about the affected joints, or in bursal thickenings between the transverse processes of the fifth lumbar vertebra and the top of the sacrum. The plates should include stereoscopic views of the lumbosacral and sacro-iliac regions, and anteroposterior and lateral views of the lumbar and low dorsal spine.

The lesions to be differentiated under the general heading of back strain are: acute traumatic strain; general postural strain; dorsolumbar strain; lumbosacral strain; sacro-iliac strain; and combined pelvic joint strain. The classification is purely clinical, without reference to the exact anatomical lesion, but is distinctly helpful.

Acute Traumatic Strain.—This lesion represents a rupture of ligamentous or muscular fibers with all the phenomena of acute injury. The connection between trauma or violent effort and the sudden development of symptoms is always definite. There is acute pain, localized over the site of the lesion, which is increased by any movement of the spine. The body is held rigidly, spasm of the erector spinae muscles is great, and all movements of the spine are resisted. A point of great

FIG. 6.—Lumbar spine. The transverse process on the right side forms a true articulation with the sacrum and the ilium. The opposite side is not equally well supported and has tilted downward with the production of scoliosis.

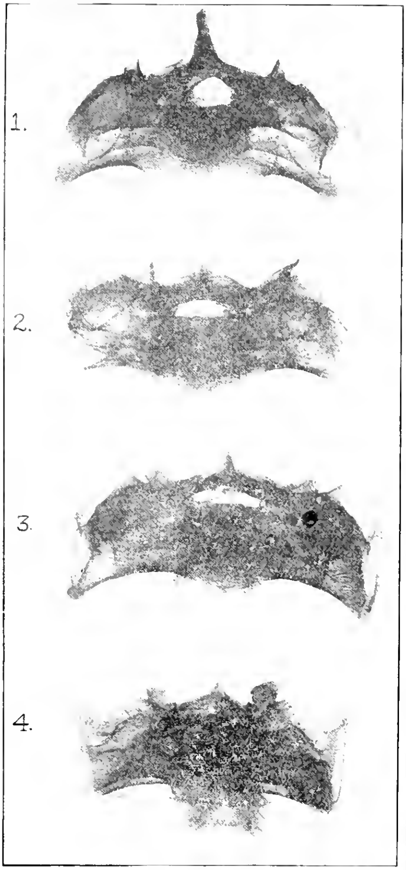

FIG. 7.—Variation in shape of articular processes of sacrum. Roentgenograms of specimens. (1) Normal processes; both crescentic. (2) Asymmetrical variation; left process crescentic, right flat. (3) Symmetrical variation; both processes flat. (4) Asymmetrical variation; both processes small but one on right particularly undeveloped.

tenderness to pressure may usually be demonstrated over the seat of injury. From its location and from the analysis of the spinal movements which are most painful a fair idea of the structures involved may be obtained.

General Postural Strain.—In this case the condition is one of general muscular fatigue and ligamentous strain and is not confined to any one joint. The complaint is of dull aching in the shoulders and low back, usually not present in the morning hours but coming on gradually as the patient becomes tired, and relieved by lying down. The patient is of the slender, asthenic type, and investigation of his social and occupational status usually shows that he lives under conditions of poor hygiene and is employed in some type of work which is particularly fatiguing or which favors the adoption of faulty postural attitudes. There is usually no nerve involvement or referred pain.

FIG. 8.—Congenital defect. Spina bifida occulta. Imperfect closure of spinal arch of first sacral segment.

Examination shows poor body mechanics and bad posture. There is no limitation of the movements of the spine or hips, and muscle spasm is absent. There may be points of tenderness to pressure between the spinous processes in the lumbar region.

Dorsolumbar Strain.—In this condition the pain is localized at the dorsolumbar junction. There may be only a dull steady pain or there may be exacerbations with acute knife-like pain on one side and evidence of nerve involvement with pain radiating forward to the chest along the course of the intercostal nerve. On examination there is found the usual sagging of the spine in the erect position. Spinal motions are usually moderately limited in the affected region but without much decrease in the total range of motion, owing to an increase in the movements of the vertebrae above and below the rigid segment. On palpation, spasm of the erector spinae muscles can be demonstrated, and there is marked tenderness, on pressure, high in the costovertebral angle.

Lumbosacral Strain.—The pain may be dull or acute and is sometimes localized in an indefinite way over the lower spine and hip, affecting chiefly one side, or in other cases is referred definitely to the lumbosacral angle. The pain is usually asymmetrical, and sciatica is a frequent symptom.

Among the various types of cases of lumbosacral strain, one in particular deserves special mention. This is the stout person with heavy, protruding abdomen. In order to accommodate the increased weight in front, the spine is tilted sharply backward at the lumbosacral junction, with production of marked lordosis. This results in strain of the iliolumbar and lumbosacral ligaments, with or without compression of the fourth and fifth lumbar roots, and sciatic pain.

Examination shows long standing bad posture. Spinal movements are usually fairly free but on lateral bending the participation of the lower lumbar vertebrae in the movement is often greater in one direction than in the other. Forward bending is often limited by spasm of the hamstring muscles, limiting the flexion of the pelvis on the hips. On palpation there is usually local tenderness, on deep pressure, in the lumbosacral angle or further out at the attachment of the iliolumbar ligaments to the iliac crests. The hip motions are free but flexion of the hip with the knee extended is usually limited on the affected side Careful nerve examination may show disturbances of cutaneous sensibility, muscular weakness, and atrophy.

Sacro-Iliac Strain.—The typical patient is usually a young or middle-aged woman, who has had one or several children. The pain is often first noticed during pregnancy when the normal physiological relaxation of the sacroiliac ligaments occurs. Following pregnancy the pain persists and consists of a dull ache through the low back, radiating to the hips and legs. Frequently the pain is noticed as much when in bed as when standing, and it is generally relieved by anything tightly encircling the pelvis. The patient is usually of the slender visceroptotic type, with relaxed abdominal wall and generally with poor body mechanics. The lateral movements of the spine are normal, but forward and backward bending are often painful or limited. Extreme abduction and external rotation of the hips are often painful, and there is marked limitation of the straight leg raising. There is marked tenderness, on pressure, over the posterior sacroiliac ligaments on one side, and this

may extend out into the gluteal region. There may also be tenderness on pressure at the symphysis pubis. Lateral compression of the crests of the ilium may be painful, and if the individual is thin, tenderness over the anterior surface of the sacro-iliac joint may be elicited by pressure through the abdomen.

Combined Pelvic Joint Strain (Sciatic Scoliosis). — Differentiation between strain of the lumbosacral and sacro-iliac regions is always difficult. In the more acute and more severe conditions the distinction is unnecessary because it is probable that they coexist, one resulting in the other. Sciatic scoliosis probably represents such a condition. It usually begins quite suddenly with severe pain in the low back, and is followed by the appearance of the characteristic sciatica. The pain is asymmetrical and so severe that the patient usually takes to his bed. After a variable period of time the back pain subsides but the sciatic pain persists and continues to be acute.

On examination the spine is seen to be listed to one side, the angulation beginning at the lumbosacral region, and one hip is more prominent than the other. All movements of the lower lumbar spine are limited and, if seen in the acute stage of the strain, are painful. Abduction and external rotation of the hip increase the pain. There is great limitation of the straight leg raising, so that on the affected side the heel can be lifted only a few inches from the bed. On the unaffected side there is similar but less marked limitation. Elevation of the leg on the unaffected side causes pain on the opposite and affected side.

Foot Strain

Anatomical Considerations.— Before considering the problem of foot strain, the arrangement of the skeleton of the foot should be recalled. The astragalus receives no direct muscular insertions of its own. Its motion is purely passive, being the resultant of the motion of the bones surrounding it. It is interposed between the tibia and fibula above, and the os calcis below, with each of which it articulates. In front it articulates with the scaphoid and, by way of this, with the cuneiforms and the three inner metatarsals. The os calcis has on its superior surface two articular facets which support the astragalus, and it articulates anteriorly with the cuboid and, by way of this, with the two outer metatarsals of the foot.

The motions of the foot are dorsiflexion and plantar flexion, supination and pronation, and adduction and abduction. Dorsiflexion and plantar flexion occur at the astragalotibial joint where, on account of the mortise-like action of the malleoli, no lateral motion is permitted. Supination and pronation, or inversion and eversion of the foot, take place almost altogether at the articulation between the os calcis and the astragalus, and are accomplished by an oblique rotation of the os calcis. Adduction and abduction are purely lateral motions of the forefoot, and occur chiefly in the anterior tarsal joints. Normally these movements scarcely exist and are demonstrable only as a sense of elasticity in the forefoot.

The foot is to be considered as an organ highly specialized for the purpose of bearing weight. Its general arrangement in arches conforms to the best mechanical principles of spring suspension. The longitudinal arch divides the weight between the heel and forefoot, while the anterior arch, by distributing the weight to the outer and

inner borders of the foot, gives practically a three point support. Normally most of the weight is transmitted to the heel and head of the first metatarsal, the outer border of the foot serving as the stabilizing arm of the tripod to prevent it from capsizing.

The arches do not, however, possess any inherent strength from the arrangement of the bones. The real support is derived from the muscles, both intrinsic and extrinsic, as may be demonstrated by the fact that the arch may be raised or lowered at will.

The action of the intrinsic muscles is like that of a bow string. They span the arch and draw the anterior and posterior pillars toward each other. The action of the extrinsic muscles is more definitely supportive. The tibialis anticus exerts a direct elevating pull on the apex of the arch. The tibialis posticus passes down behind the internal malleolus and is inserted into the scaphoid, and then spreads out across the foot, tending to sling the arch. The peroneus longus has almost the same function, but in a reversed direction, passing across the bottom of the foot from the outside and being attached to the internal cuneiform and first metatarsal bones. The flexor longus hallucis is another strong muscle with direct supportive function. As it extends forward to the great toe from behind the internal malleolus, it passes directly beneath the sustentaculum tali, which serves as a pulley to change the direction of the tendon. With the great toe fixed as in weight bearing, contraction of this muscle elevates the sustentaculum and supports the arch. The other muscles of the foot have also a supportive function but are relatively of less importance. (See Fig. 9.)

Etiology of Foot Strain.—As has been pointed out by Osgood and Brown, none of the muscles of the foot has a simple action. While their function may be supportive when the foot is supinated, the action may be distinctly reversed when the foot is pronated. Supination raises the arch, while pronation tends to flatten it. In a general way, therefore, the supinating muscles may be regarded as the benevolent or supportive group, and the pronators as the malevolent or destructive group. Preservation of normal foot balance is dependent upon the supinating muscles being stronger than the pronating group. When the strength of these muscles is measured, the normal ratio is found to be as 5:4, in favor of the supinators. In weak feet the balance is even, and in conditions of foot strain the ratio is usually reversed.

The height of the arch has, however, no special significance in relation to foot strain, as it varies normally with

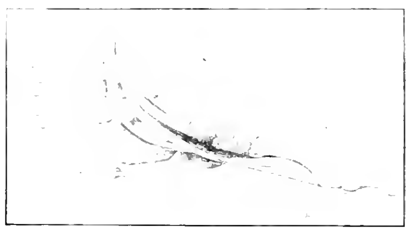

Fig. 9.—Mesial aspect of foot showing arrangement of tendons. Note the course of the flexor longus hallucis. F.L.H.=flexor longus hallucis; F.L.D.=flexor longus digitorum; T.P.=tibialis posticus; As.=astragalus; T.A.=tibialis anticus; E.L.H.=extensor longus hallucis; E.L.D.=extensor longus digitorum; A.H.=adductor hallucis.

different types of individuals. The slender type of body is usually associated with a slender, high-arched foot, while with the heavy type of body the arch is normally low and the foot broad. In the former a slight degree of strain may prove exceedingly painful, whereas in the latter the foot may be perfectly strong with normal muscle balance and yet the arch may be so low as barely to escape contact with the ground.

Nevertheless, relaxation of the foot with flattening of the arch is commonly associated with foot strain. When the normal muscular support weakens, the strain falls on the ligaments, but these being plastic structures stretch, and deformity follows. The foot pronates and the os calcis rotates outward. The head of the astragalus pitches downward and inward, exerting a direct thrust on the calcaneoscaphoid ligament and forming an abnormal prominence. At first the deformity may be correctible, but with time the ligaments become tightened in their new position and actual bony changes may occur. The forepart of the foot is abducted, owing to the pushing downward and forward of the head of the astragalus. The inner border of the foot, instead of remaining straight, becomes convex, motion is limited, and correction of the deformity becomes impossible.

Although it is possible anatomically to differentiate between the anterior and the longitudinal arches, from the physiological standpoint such distinction is purely artificial. They are so closely interrelated in the function of weight bearing that relaxation in one is certain to be associated with weakening of the other. From the clinical standpoint, however, this distinction is helpful as symptoms may appear more prominently in one than in the other.

The causes of foot strain as usually given are multitudinous and include such things as sudden increase in body weight, change from a sitting to a standing occupation, or conditions of a general nature, such as long illness, general debility, inactivity, and all other factors which may result either in overuse and fatigue of the muscles, or in weakening of the muscles and loss of normal tone. Of far greater importance, however, are the effects of improper shoeing and faulty use of the body.

Improper shoes may lead to foot strain in several different ways. Pointed shoes crowd the toes and disturb the balance of the anterior arch. High heels transfer the entire thrust of the body weight to the forefoot and lead to relaxation of the anterior arch and weakening of the general supportive mechanism. Most shoes are too short for the feet they contain, and in weight bearing the normal spring of the longitudinal arch is prevented. The foot must expand in some manner and, since the toe cap prevents expansion from taking place in the forward direction, it occurs transversely with flattening and broadening of the anterior arch. This interferes with the proper functioning of the foot, weakening it to such an extent that strain may sooner or later occur.

Faulty use of the body weakens the foot by neglect of the normal weight-bearing mechanism. The foot is designed for use when the body is in the erect posture. In this position the weight of the body is transmitted to the apex of the arch with a perpendicular thrust which permits its even distribution between the heel and the forefoot. Balance is easily maintained by normal muscular tone and the work is evenly divided among the various muscles. In positions of faulty posture, however, this is not the case. The weight falls more heavily on the heels, and certain of the muscles are relaxed while others carry more than their fair share of the load. The overworked muscles become fatigued and lose their tone, while those which are not sufficiently used atrophy. The inevitable result is weakening of the foot, disturbance of muscle balance, and ultimate strain.

Faulty gait is included under the same general heading. The primitive gait is one in which the foot is pointed directly forward. In this position, not only are the extrinsic and intrinsic muscles of the foot utilized to the best advantage but considerable additional support is obtained from the short external rotating muscles of the hip which, when the foot is fixed on the ground, as in weight bearing, exert a distinct supinating effect. It is a matter of common observation that the usual gait of most people is one with the toes pointing outward. In this position no support is derived from the hip muscles, and as the foot is used it is habitually pronated.

Diagnosis.—In the differentiation of various conditions affecting the feet, it is as necessary to obtain a careful history as in any more general complaint. Special inquiry should be directed toward the various causes which have already been mentioned. The examination should include inspection in the standing and walking positions, with especial reference to posture, general musculature, and gait. Presence or absence of pronation should be noted, and the posterior aspect of the heels observed for outward rotation of the os calcis. Abduction of the forefoot, broadening of the anterior arch, and hallux valgus may be readily perceived. The presence or absence of congestion, swelling, abnormally free perspiration, etc., are also important. Corns denote boot pressure, and search should be made on the plantar surface for callosities, the sign of abnormal weight bearing. The shoes should also be examined to see whether their lines are good or bad. Bulging of the anterior portion usually indicates bad fitting, while the presence of worn over edges at the heels gives an indication of the usual tread.

Examination of the feet should include a careful search for points of tenderness, with especial reference to the attachments of the calcaneoscaphoid and plantar ligaments and the under surfaces of the metatarsal heads. All motions of the foot, including dorsiflexion and plantar flexion, supination and pronation, adduction and abduction, and motions of the toes, should be tested. Painful or limited movements should be analyzed from the standpoint of the joint involved and of the structures surrounding that joint.

Considerable help may be obtained by determining the strength ratio of the supinating and the pronating muscle groups. This may be readily measured by a spring balance, one end being fastened to the forefoot and the other to a flat wooden support on which the heel rests. During the test the knee should be supported by the hands to prevent rotation of the femur and use of the hip muscles. (See Fig. 10.)

The various types of foot strain to be differentiated are the following:

1. Acute foot strain.
2. Metatarsalgia.
3. Chronic foot strain.
   a. Chronic strain with only slight pronation.
   b. Chronic strain with pronation but no rigidity.
   c. Rigid flat foot.

Acute Foot Strain.—This condition occurs either as the result of trauma or as an acute giving way of the supporting structures of the foot from excessive use or unaccustomed activity. It may develop suddenly or may follow prodromal symptoms which have been disregarded.

The chief symptom is severe pain localized over the mesial and posterior plantar aspects of the feet, and radiat-

ing up the legs to the knees. The pain is constant but is much increased by weight bearing. Walking is difficult and limping occurs.

Examination shows little or no pronation, and the feet may appear quite normal save for moderate congestion. There is no restriction of motion but supination and pronation may be slightly painful. There is marked tenderness on pressure over a rather large area under the forward portion of the os calcis extending to the mesial surface, and this tenderness may be accompanied by slight swelling.

Metatarsalgia.—This condition is due to relaxation of the anterior arch with strain of the supporting ligaments and painful pressure on bones which normally should not bear weight. The complaint is always of pain under the ball of the foot. On examination the forefoot is found to be flattened transversely and broadened. The toes appear crowded together, and the great toe deviates outward instead of pointing straight ahead. Callosities can usually be found on the plantar surface under the middle of the transverse arch, and pressure on the heads of the second, third, and fourth metatarsals from the plantar surface is painful.

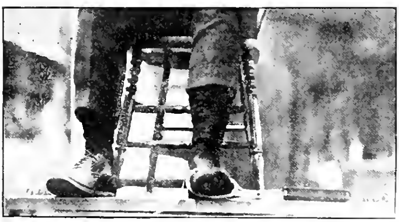

Fig. 10.—Determination of relative strength of supinating and pronating muscles. Measuring the strength of the supinators.

"Morton's toe" is a special form of metatarsalgia. The complaint is classical and consists of intermittent attacks of severe pain localized at the base of the fourth toe. The attacks come on without assignable cause, usually while the person is walking along the street, and the pain is so severe that the shoe must be removed immediately and the toe manipulated in order to obtain relief. The cause has never been completely established, but the condition is always associated with relaxation of the anterior arch, and in certain positions it is probable that a digital branch of the plantar nerve is compressed between the adjacent metatarsals.

Chronic Foot Strain.—The symptoms are subacute and appear gradually. There is at first a feeling of excessive fatigue in the feet and inability to stand without constantly shifting the weight first to one foot and then to the other. Gradually the feet become definitely painful, the pain being noticed chiefly during the day when one is standing or walking, or in the evening following a day of severe exertion. The pain is distributed rather indefinitely to the feet and legs. On examination different degrees of the condition may be differentiated.

a. In the first stage, there is only slight pronation and all movements may be performed without pain or limitation. The only positive signs are alteration of the normal muscle balance, revealed by measurement with the spring balance, and slight tenderness on pressure under the calcaneoscaphoid ligament.

b. In the second stage, there is well-marked pronation of the feet but no limitation of motion.

c. In the third stage, there is not only marked pronation, but definite limitation of movement as well. The feet may be almost rigid, owing to the con-

traction of ligaments and muscles, or there may be true ankylosis resulting from an arthritis. In other cases the limitation may apply only to certain movements, the others remaining free. In this case the rigidity is due to muscle spasm involving either the peroneal or gastrocnemius muscle groups. The latter occurs quite frequently in persons accustomed to wearing high heels, and is of itself an important factor in the production of foot strain.

Back and Foot Strain Considered Jointly

From what has been said under the separate consideration of back and foot strain, it has been seen that faulty body mechanics is the essential factor in the production of both. In the former, the mechanical derangement is one of posture; in the latter, it is not only a question of posture but in addition one of gait and interference with foot function by improper shoes.

It is evident, therefore, that the two conditions are closely related. Whether the symptoms first appear in the spine or in the feet, depends chiefly upon where the greatest strain falls and also upon the individual's point of least resistance. The two conditions may be present at the same time, and it is often difficult to determine whether the case is primarily one of back strain or foot strain. The practical import of this is that in some instances foot symptoms may be secondary to back strain, while in others a complaint of backache may be relieved by treatment of the feet.

The fundamental law of body mechanics is that a line dropped through the center of gravity must fall within the base of support. This is essential to the upright position. If any portion of the skeleton lies in front of the center of gravity, it must be counterpoised by a compensatory projection behind the line to keep the center of gravity over the base of support as represented by the feet. In the normal erect posture with the head back, chest up, abdomen in, and the spinal curves relatively flat, a line dropped from the atloido-occipital joint, the highest joint in the body, should fall perpendicularly through the astragalo-scaphoid articulation, the apex of the longitudinal arch. When this occurs, the body is in the position of greatest stability.

When this position is altered by sagging of the body at any point, compensation is obtained by a corresponding change at some other point. The skeleton possesses immense resources for compensation in this way, and thus faulty body mechanics may be supported for a long time without actual damage. The more the reserve compensatory power is diminished, however, the nearer the appearance of symptoms of strain. The ability to compensate varies with each individual and seems to be dependent upon the skeleton structure, and it is in this connection that variations in anatomic structure seem so important.

Prevention

For the last few years at several universities all the members of the entering classes have been systematically examined and an attempt made to group them according to whether their body mechanics were (A) very good; (B) good; (C) poor; or (D) very poor. (See Fig. 11.) Those falling in groups C and D have been selected for treatment by corrective exercises and demonstration of the proper use of the body. It has been found surprisingly easy, in a large number of these cases, to correct

bad habits of many years' standing, so that individuals have been brought from group D to C or even to B.

Prevention of back and foot strain among industrial workers resolves itself into the introduction of a similar procedure. Certainly much can be said in favor of such a plan, and the advantages in the way of better general health, increased efficiency, and decreased disability would probably more than offset any objections which might be raised. It should at least be possible to make a beginning by application of the procedure to all new employees. An element of compulsion is advantageous and should consist of placing individuals with poor body mechanics on probation for a certain period, holding regular employment and full pay as the prizes to reward good work and correction of faulty statics.

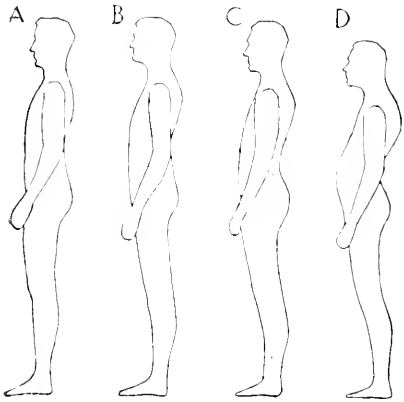

Fig. 11.—Tracings made during examination of 700 Harvard Freshmen.

Group A.—7.5%. Good mechanical use of the human body: (1) head straight above chest, hips and feet; (2) chest up and forward; (3) abdomen in or flat; (4) back, usual curves not exaggerated.

Group B.—12.5%. Fairly good mechanical use of the human body. Note changes from Group A: (1) head too far forward; (2) chest not so well up or forward; (3) abdomen, very little change; (4) back, very little change.

Group C.—55%. Bad mechanical use of the human body. Note changes from Group A: (1) head forward of chest; (2) chest flat; (3) abdomen relaxed and forward; (4) back curves exaggerated.

Group D.—25%. Very bad mechanical use of the human body. Note changes from Group A: (1) head still farther forward; (2) chest still flatter and farther back; (3) abdomen completely relaxed—"slouchy"; (4) back, all curves exaggerated to the extreme.

Treatment

Treatment of the various lesions that have been outlined is again fundamentally a matter of correcting faulty body mechanics. The conditions here are different, however, because we are dealing with ligaments that are already strained and muscles that are fatigued. The immediate institution of corrective exercises is no more logical than whipping a tired horse to make him trot.

The first and immediate requirement is rest. Complete rest of the affected structure can only be obtained by recumbency in bed with the removal of gravity as a deforming influence. This is necessary in the severe cases and advantageous even in the mild cases, in that it hastens recovery. When complete recumbency is inadvisable or unnecessary, the injured structures should be rested by the application of some type of brace which removes the strain and secures relaxation of the ligaments.

In the case of back strain this requirement is met by the application of a simple type of brace which spans the exaggerated lumbar curve against which the lower spine may be flattened by means of a belt encircling the pelvis and exerting an upward lift on the abdomen. (Figs. 12 and 13.) The application of a tight adhesive strapping across the back of the pelvis gives relief in certain cases, particularly those with sacro-iliac strain. In cases of

acute traumatic sprain the strapping should extend well above the pelvis and be placed in such a manner as to limit the function of the injured muscles or ligaments. Frequent rest periods through the day, even though of short duration, are important. Hot fomentations applied along the length of the spine twice a day are helpful in producing local congestion and stimulating repair.

FIG. 12.—Short back brace used in case of back strain.

In the case of foot strain one of the first steps should be the replacement of improper footwear by shoes of good line and ample size. Rest and relaxation of the strained structures may be obtained by different types of braces or dressings. The longitudinal arch may be padded with felt and retained by a stirrup strapping of adhesive which holds the foot well supinated. (Fig. 14.) The anterior arch may be similarly supported by an encircling band of adhesive with felt pads placed beneath the metatarsals. More permanent support may be obtained by the use of Thomas' heels, the inner border being raised $\frac{1}{4}$ inch and extended forward $\frac{1}{2}$ to $\frac{3}{4}$ inch. (See Fig. 15.) Painful pressure on the metatarsal heads may be relieved by nailing a strip of leather 1 inch wide and $\frac{1}{4}$ inch thick obliquely across the sole just behind the tender area. This is illustrated in Figure 16.

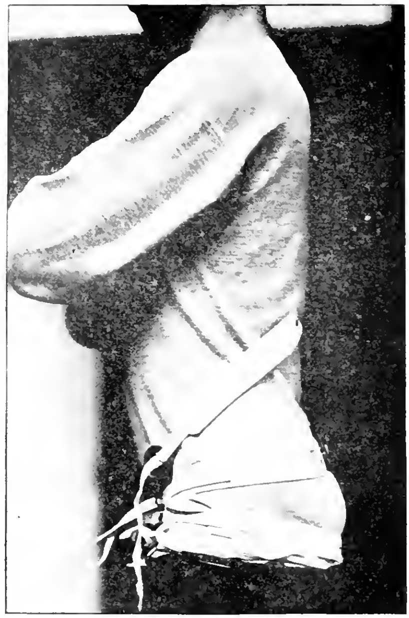

FIG. 13.—Lateral view of back brace.

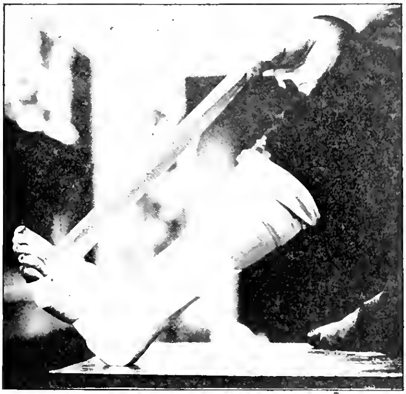

Fig. 14.—Adhesive strapping for foot strain. Foot strapped in inversion.

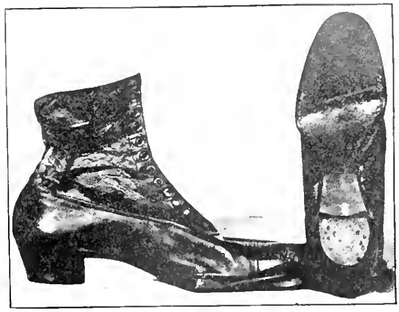

Fig. 16.—Metatarsal bar ¼ inch thick extending across sole just behind the heads of the metatarsals.

In mild cases sufficient support may be obtained for the longitudinal arch by the use of a figure 8 leather ankle strap, or for the anterior arch by a laced leather foot cuff. (See Figs. 17 and 18.) The use of foot plates is more difficult and in only a small percentage of the cases are they necessary. Stock plates of different sizes, types of which are shown in Figure 19, may be kept on hand or plaster impressions of the feet may be taken from which special supports can be made. Alternating hot and cold contrast baths are helpful in improving the circulation, and the feet should be kept elevated as much as possible.

In both the back and foot cases after a sufficient period of rest, as shown by the subsidence of the painful symptoms, corrective postural training should be begun. Not only should the essentials of good posture be demonstrated but the patient should be shown in a mirror in what respects his own body mechanics are bad. He must be taught how to flatten the spine and pull himself erect. The abdominal muscles must be strengthened and he must learn to ro-

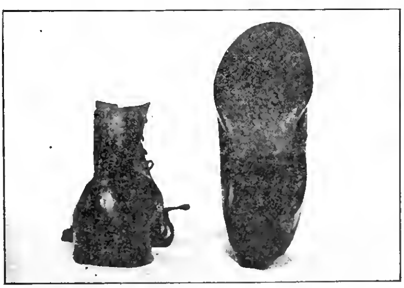

Fig. 15.—Thomas' heels. Inner border raised ¼ inch and extended forward ½ inch.

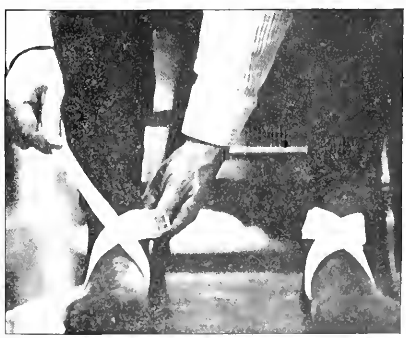

Fig. 17.—Figure 8 ankle straps for support of weak feet.

tate the pelvis, in order to decrease its inclination, and to hold the chest elevated and breathe with the diaphragm.

In cases of foot strain, in addition to postural training, emphasis should be placed on the correction of improper gait by toeing straight ahead or slightly inward, thus using the extrinsic leg muscles to support the arches. Special exercises, such as picking up marbles with the toes, are helpful in strengthening the supinator muscles and toe flexors.

Fig. 18.—Anterior arch cuffs for relief of metatarsalgia.

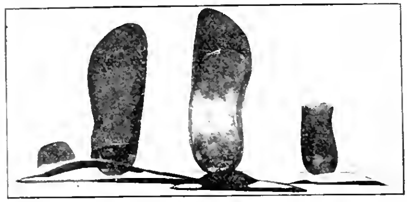

Fig. 19.—Different types of arch supports required for extreme cases.

Last to be considered are the cases of rigid flatfoot. The problem here is to restore flexibility. The contracted tendo achillis may be stretched out by proper exercises. Peroneal spasm may require manipulation or open operation. Ankylosed feet require open operation with simple osteotomy or removal of a wedge of bone to restore the normal lines of weight bearing.

OCCUPATIONAL SICKNESS: A REVIEW*

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Introduction

THE increasing interest taken in the study of such questions as hours of labor, rest pauses, ventilation, and lighting, has compelled more and more recognition of the fact that unhygienic conditions in factory or workshop must sooner or later result in reduced vitality, which in its turn produces lessened output with consequent financial loss to both employer and employed. Conversely, it may be said that where reduced vitality is found to exist it is caused by some unhygienic condition. Thus, reduced vitality becomes a finger post pointing the direction to further research.

Hence some attempt should be made to obtain a measure of it in various industries. In England and Wales the Registrar General's Occupational Mortality Returns are generally used for this purpose. For instance in 1910 to 1912 (the last available data), while the comparative mortality among males for the whole country, from all causes, was 790, that among stone-getters and masons was 1,427, among cutlers and scissor-makers 1,285, among potters and earthenware-makers 1,196. The reduced vitality shown in these three industries is due mainly to unhygienic conditions conducing to the inhalation of dust and producing a special form of phthisis.

As is well known, several causes combine to make these official mortality returns unsatisfactory. They are published only at intervals of ten years. They refer only to the occupation in which a man is believed to have been engaged at the time of death. Reduced vitality may not always lead directly to death, and impairment of health not infrequently leads to change of occupation; with the result that the death is credited to the secondary occupation and not to that which has actually produced it. Moreover, the effect of any change in industrial conditions takes long to show itself in mortality, while the conditions of an industry may themselves be undergoing rapid change, as in the case of the boot and shoe trade—a trade which has been completely revolutionized within the last quarter of a century.

Sickness affords a more satisfactory measure. It not only makes its effect felt much more quickly, but generally occurs while the victim is at his occupation, to which he usually returns again when sufficiently recovered.

Previous Investigations

American.—The value of investigations into the occupational incidence of sickness is being more and more realized both in Great Britain, and on the Continent, and in the United States. In the United States two interesting attempts have been made recently to obtain information as to occupational sickness.

1. Between 1915 and 1920 the Metropolitan Life Insurance Company of New York published ten treatises on the subject, of which the last, under

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the title of "Some Recent Morbidity Statistics" (1), was published in 1919, and summarized the results obtained in the others. The regions selected were Rochester, N. Y., North Carolina, Boston, Mass., Chelsea (N. Y. City), Pittsburgh, Pa., West Virginia, and Kansas City. The surveys were made during 1915, 1916, and 1917 by the agents of the company when going their rounds of weekly collections, and were generally spread over a fortnight, different regions being dealt with at different times of the year. The particulars included statements as to the number of persons visited, age, sex, whether in good health or sick, and, in the latter case, the cause of sickness, its duration, and whether it was sufficiently severe to incapacitate for work. The figures are interesting as they bring out the fact that the main causes of illness were in all localities the same —*viz.*, external violence, rheumatism, influenza and other epidemic diseases. No mention was made of alcoholism or venereal diseases, but these were doubtless concealed under some more obvious ailments. Information as to occupation was, however, very scanty, so that the results give very little more than the sickness prevailing in the particular region at the actual moment that the inquiries were made, and do not throw light upon its occupational incidence.

2. In December, 1920, the Statistical Office of the United States Public Health Service (2) gave the first results of an attempt to "collect, tabulate and publish information concerning the prevalence of diseases among the wage-earning population." The figures were supplied by "sick-benefit associations of the employees of certain plants, which are cooperating with the Public Health Service." They are for the first half of 1920, and, being in the nature of a first attempt, are somewhat fragmentary. They show the number of cases of sickness causing inability to work for one week or longer in each month of onset, and give the cause. No information is given as to age, neither are the sexes differentiated, but it is stated that females constitute a negligible proportion. A disturbing factor was the occurrence of epidemic influenza in the first three months, accounting for half the total cases in January and February, and one-third in March. No attempt is made to classify the data occupationally, but the hope is held out of more detailed analysis in later publications. If this gives the data in occupations, useful light may in time be thrown on the causes of occupational sickness in the United States. The rates shown in different associations vary widely, leading to the remark that "these marked differences afford strong reason for a careful study not only of the causes of illness in the different plants, but of the conditions which give rise to them. . . . The value of statistics of this nature will, it is believed, become more manifested as they accumulate."

Continental.—In Germany and Austria the operations of the systems of sickness and invalidity insurance for the past thirty or forty years have enabled several investigations to be made. Some of these are reported by Blaschke (3) and, in more detail, by Prinzing (4). These were both published in 1906, but it was not until four years later that one of the best and most comprehensive analyses became available. This is the Leipzig Sickness and Mortality experience 1887-1905, published in 1910 (5). It gives the number of cases and the days and causes of illness experienced in twenty-four main occupations

among insured members in the sickness associations in Leipzig and its neighborhood. The authors considered that the experience was sufficiently representative of the insured industrial population of the whole country to be treated as a fair guide. The main industries were: (*a*) for men—building trade (17 per cent.), metal industry (16 per cent.), printing and paper (11 per cent.), offices and shops (10 per cent.); (*b*) for women—printing and paper trade (22 per cent.), tailoring (20 per cent.), hotels, inns and refreshments (13 per cent.), offices and shops (13 per cent.).

The nature of the attacks of sickness, their number, and their duration were set out in twenty-four main headings of occupation, subdivided where the facts were sufficient into 108 groups of trades for men, and 79 for women. The causes of sickness were given under five main headings, further subdivided with characteristic over-elaboration into no less than 335 subheadings. The records for male and female lives are throughout kept separate but no attempt is made to divide the latter into married and single. Table 1 gives a summary of the rates of attack and sickness in ten groups of diseases. A compilation of this kind is not only a monument of labor; it is a mine of wealth for statistical comparisons. In such a detailed analysis the numbers, however, are in most instances necessarily small, especially when age incidence is (as it must be) taken into account. Moreover, seeing that the facts relate to a long period of years during which vast changes have taken place in industrial conditions, the results cannot be considered as representative even of German industry at any given time.

Great Britain.—The only standard of comparison in this country is the Manchester Unity, 1893-1897 (6), and this does not analyze sickness into causes nor does it give any data at all for female lives. Even for occupations it gives only a few broad groups. But taking all causes of sickness and all occupations combined, the Leipzig sickness rates are much heavier.

For records of sickness in the United Kingdom one naturally turns first to the old Trade Guilds and their modern successors, the Friendly Societies. It was a century ago that the first attempt at an investigation, on right principles, of sickness rates was made on a comprehensive scale. Since the publication of Ansell's tables in 1828, a number of similar investigations have been made with an ever-increasing volume of data (6). Nearly twenty years after Ansell, Neison published the first edition of his well-known "Contributions to Vital Statistics," in which he gave the results of his investigations into the experience of a large number of Friendly Societies operating in England, supplementing this in a later edition with records obtained in Scotland. Later, in 1854 and 1896, the State published the results of two investigations into the collective experience of Registered Friendly Societies, now generally known by their authors' names—Finlaison (7) and Sutton (8). A summary of these is given in Table 2.

Large individual societies having affiliated branches also began to publish their experiences. Chief of these was the Manchester Unity (9), which has made altogether four such investigations. The last of these dealing with the period 1893-1897 has already been referred to and is at the present time the standard table of sickness in Great Britain. It forms the basis of the financial provisions of the National Insurance Acts.

TABLE 1.—RATES OF ATTACK AND OF SICKNESS AMONG INDUSTRIAL WORKERS IN ALL OCCUPATIONS, LEIPZIG, 1887-1905[1]

Cause	No. of Attacks per Annum among 100 Persons in Each Age Group										Weeks of Sickness per Annum among 100 Persons in Each Age Group									
	Males					Females					Males					Females				
	15-24	25-34	35-44	45-54	55-64	15-24	25-34	35-44	45-54	55-64	15-24	25-34	35-44	45-54	55-64	15-24	25-34	35-44	45-54	55-64
Influenza	2.11	2.93	3.48	3.79	4.28	2.10	3.60	5.07	5.61	4.91	3.7	6.1	8.3	10.7	14.5	4.6	9.2	14.4	16.6	19.8
Phthisis and tuberculosis	0.55	0.82	1.03	1.01	0.90	0.53	0.83	0.85	0.78	0.58	6.3	9.1	12.4	11.9	11.0	6.0	10.0	10.3	8.3	6.5
Rheumatism	2.10	3.59	5.63	7.49	8.59	1.23	2.49	4.77	6.37	6.75	4.6	9.2	16.2	24.5	34.9	3.6	8.0	16.4	24.7	29.2
Diseases of respiratory system	4.70	5.20	6.08	7.79	11.18	3.87	5.93	7.16	7.45	9.02	14.1	19.0	24.0	35.2	60.3	14.5	26.8	31.7	33.7	42.9
Diseases of circulatory system	1.39	1.10	1.13	1.43	1.88	8.59	7.69	5.78	3.87	2.67	5.1	4.2	5.2	7.5	13.1	31.7	31.5	27.7	18.7	17.5
Diseases of digestive system	5.86	6.12	5.72	6.10	7.05	8.19	9.83	10.08	10.12	8.18	10.1	12.9	14.3	17.9	25.0	18.9	27.8	32.6	30.7	27.1
Diseases of nervous system	0.74	1.24	1.93	2.40	2.66	1.03	1.89	2.55	2.62	1.66	2.7	5.6	10.1	13.2	16.9	4.1	8.1	12.0	12.9	9.1
Diseases of skin	4.36	3.14	3.49	3.85	4.07	2.72	2.83	3.60	4.58	4.16	7.9	6.8	9.3	13.1	17.6	6.4	8.8	13.9	20.4	21.2
Other causes	4.86	4.48	4.27	4.88	5.62	5.91	7.91	7.44	6.36	5.10	14.7	14.5	15.9	22.1	31.1	21.5	33.9	33.2	33.2	28.4
Total	26.67	28.62	32.76	38.74	46.23	34.17	43.00	47.30	47.76	43.03	69.2	87.4	115.7	156.1	224.4	111.3	164.1	192.2	199.2	201.7
Accidents	9.74	8.15	9.48	9.95	9.83	2.76	2.59	3.06	3.87	4.72	21.7	20.3	27.4	33.9	38.1	7.1	7.9	10.0	13.7	18.0

[1]Illness due to accidents and the puerperal state is excluded.

TABLE 4.—DAYS OF SICKNESS PER ANNUM AMONG WORKERS IN THE IRON AND STEEL INDUSTRY FROM VARIOUS CAUSES DURING THE YEARS 1913-1918[1]

Male Lives

Occupation	Rheumatism				Respiratory Diseases				Compensated Injuries				All Other Sickness and Injuries				All Causes			
	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69	16-29	30-44	45-54	55-69
Steel melters, teemers and pitmen	0.3	1.0	1.6	2.3	1.6	1.9	2.5	3.9	1.0	1.2	1.4	1.4	2.7	2.5	4.8	4.2	5.6	6.6	10.3	11.8
Puddlers	0.6	0.9	1.7	3.1	1.0	1.7	3.4	4.1	0.2	0.5	0.8	1.0	0.8	2.2	3.0	4.7	2.6	5.2	8.9	12.9
Tinplate mill men	0.4	0.7	1.4	3.1	1.9	1.9	2.2	3.8	0.7	0.5	0.9	1.4	3.2	3.1	4.3	5.2	6.2	6.2	8.8	13.5
Rolling mill men, soaker men, hot bank men	0.4	0.7	1.5	2.0	1.7	1.8	2.0	3.4	0.6	1.0	1.0	2.3	2.7	2.7	4.0	7.0	5.4	6.2	8.5	14.7
Engine men, crane men, locomotive men	0.3	0.6	0.6	0.8	1.9	1.8	2.8	3.7	0.3	0.5	0.3	0.8	2.6	2.1	3.0	5.8	5.1	5.0	6.7	11.1
All other workers (largely laborers)	0.3	0.7	1.3	1.6	1.6	1.6	2.1	3.6	0.4	0.5	0.7	0.8	2.2	2.5	3.0	4.6	4.5	5.3	7.1	10.6
All workers combined	0.3	0.7	1.3	1.9	1.6	1.7	2.3	3.7	0.5	0.6	0.8	1.0	2.4	2.6	3.5	5.0	4.8	5.6	7.9	11.6

[1]Illness termed "disablement" in the National Health Insurance Acts and illness due directly to war are excluded.

TABLE 2.—WEEKS OF SICKNESS PER ANNUM AMONG 100 PERSONS IN EACH AGE GROUP SHOWN BY VARIOUS INVESTIGATIONS INTO THE GENERAL EXPERIENCE OF FRIENDLY SOCIETIES

MALE LIVES

Investigation	Ages								
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
Ansell, 1823-1827	78.5	82.5	89.3	100.9	119.5	147.5	189.0	258.6	399.1
Neison:									
England and Wales, 1836-1840	85.7	89.0	91.7	103.6	127.3	163.4	218.0	304.9	474.6
Scotland, 1831-1842	87.7	86.6	79.9	90.0	105.0	139.2	218.4	291.9	450.6
Finlaison, 1846-1850									
England and Wales	98.1	98.4	98.1	108.4	122.7	143.7	177.3	219.6	308.0
Light Labor:									
(*a*) Without exposure to weather	88.6	86.4	84.6	95.4	105.1	126.7	167.4	208.7	284.9
(*b*) With exposure to weather	84.0	84.4	80.1	93.6	104.9	117.3	149.7	154.4	191.1
Heavy Labor:									
(*a*) Without exposure to weather.	98.3	98.1	102.3	108.7	123.9	151.1	197.9	248.0	320.4
(*b*) With exposure to weather	104.3	108.3	110.3	122.0	141.7	163.1	187.0	237.0	361.9
Sutton:									
England, 1856-1860	91.2	89.5	91.8	106.5	129.0	165.3	213.5	322.8	495.8
England, 1861-1870	97.2	97.5	105.7	115.3	135.7	167.4	222.1	321.3	500.8
Wales, 1856-1875	104.5	106.7	109.5	122.7	147.5	183.5	225.7	291.7	526.5
England and Wales, 1876-1880	85.5	87.3	102.3	124.0	146.8	188.9	239.3	336.5	517.3

TABLE 3.—WEEKS OF SICKNESS PER ANNUM AMONG 100 PERSONS IN EACH AGE GROUP SHOWN BY VARIOUS INVESTIGATIONS INTO THE MANCHESTER UNITY FRIENDLY SOCIETY'S EXPERIENCE

MALE LIVES

Investigation	Ages								
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
1846-1848	67.8	75.8	83.7	94.0	117.0	151.5	203.0	320.6	505.9
1856-1860	82.9	82.0	85.8	100.4	123.9	154.5	201.1	302.5	463.8
1866-1870	75.4	80.6	92.8	106.2	126.1	163.6	222.2	304.7	471.5
1893-1897									
Whole Society	89.7	95.5	106.4	126.5	158.0	198.6	274.6	402.5	630.7
A. H. J. Agricultural and General	82.1	87.0	96.6	113.8	144.3	181.1	253.9	376.2	585.0
B. C. D. Outdoor (building, railway, seafaring, etc.)	95.2	99.8	117.2	144.9	174.5	230.2	314.3	457.4	716.6
E. F. (Quarry, iron, steel, chemical, etc.)	119.6	129.7	145.7	166.3	212.4	256.5	316.2	500.1	828.1
G. Mining	146.0	165.9	182.6	225.5	269.6	344.8	484.8	646.0	1093.1
C. Railway servants	116.5	115.2	121.5	158.8	175.3	201.3	277.0	394.0	793.2

Most of the investigations make some attempt at analyzing sickness in broad groups of occupation. For instance, as shown in Table 3, the Manchester Unity, 1893-1897, gives sickness rates by age groups in respect to the following general classes of workers: (1) agricultural and general; (2) outdoor (building, railway, seafaring, etc.); (3) quarry, iron, steel, chemical, etc.; (4) mining; (5) railway servants. The results of these investigations tend to show that next to age, which has the most effect, occupation

is the most important factor in determining the amount of sickness, and that while locality and density of population may probably have a minor effect, it cannot generally be dissociated from that due to occupation. But in none of the investigations has any attempt been made to analyze sickness into its various causes. Generally speaking, the records kept did not give the information required for this purpose, and in the few instances where the facts were given they were in such a form that their compilation would have involved an inordinate amount of time and expense. Another great defect in these returns is that there are none of any value referring to female lives, so that it may be said that up to the present time no reliable statistics of sickness among female lives have been published in the United Kingdom. Neither are there any general sickness statistics for the country corresponding to those which the Registrar General publishes for mortality.

The reason for this unsatisfactory state of affairs is not far to seek—namely, that hitherto sickness statistics in this country have been viewed mainly from the financial standpoint—that is, in their bearing upon the relations between contributions payable and benefits receivable in the operations of Friendly Societies.

Recent Investigations in Great Britain

With regard to the public health, sickness statistics of a more or less general character are available as to epidemics, sanitation and similar matters; but with regard to the effect of conditions of occupation no detailed figures have been published, though their importance was indicated long ago by both Neison and Finlaison.

The introduction of the National Health Insurance scheme into Great Britain nearly ten years ago suggests a possible fruitful field of exploration. The medical certificates required before payment of sick benefit give the causes of illness, and these are recorded in the registers or on record cards, so that it is within the bounds of possibility to analyze them statistically. The diagnoses may not always be as accurate as might be desired, but experience already gained in their treatment tends to show that the records may be used in broad groups with sufficient precision. Only in comparatively few instances does it seem probable that the disease recorded on the certificate fell very widely outside the general group of illness to which it naturally belongs.

The causes of death given in much detail by the Registrar General in the decennial returns of occupational mortality are open to almost as much objection upon other points, but nobody would suggest that they should therefore be ignored in investigations into the effect of occupation upon mortality.

A question arises, however, as to how the records for particular trades can be isolated with sufficient accuracy for comparative purposes. Under the National Health Insurance Acts, the occupation is stated only at entry into a society, and in the great majority of cases no subsequent changes of occupation are noted. Moreover, a member once entering an approved society cannot be turned out because he has entered upon a different trade. He has, however, the power within certain limitations to transfer from one society to another; and, in the case of societies dealing with particular trades, the members do as a matter of fact transfer if there is available a similar trade

society dealing with the new occupation upon which they are entering.

Hence in societies with membership restricted to a particular trade, mainly of the "trade union" order, comparatively little error would be caused by treating all members as belonging to a particular trade. On this assumption the Industrial Fatigue Research Board has made a tentative start upon the iron and steel industry, foundry workers, the boot and shoe trade, and others. The results for the first named industry were published in 1920 in a very interesting report entitled "Fatigue and Efficiency in the Iron and Steel Industry" (10).

Iron and Steel Industry.—An analysis of the data was made in six groups of occupations: (1) steel smelters, teemers and pitmen; (2) puddlers; (3) tinplate mill men; (4) rolling-mill men, etc.; (5) engine, crane and locomotive men; and (6) other workers. Rates of sickness were obtained in age groups for rheumatism, respiratory diseases, injuries, and other causes, respectively. The total number of years of life observed was no less than 112,887, involving 972,932 days of sickness. It was found that the first two groups showed, for all causes and ages combined, rates of sickness over 20 per cent. above the average for the whole industry. This excess was largely made up of illness from rheumatism. Especially was this the case among the puddlers, who had an excess of 78 per cent. above the average from this cause. They also had an excess of 35 per cent. from respiratory diseases. This was probably due to the custom followed by many puddlers of alternating periods of extremely hard work, generally of about twenty minutes' duration, with periods of similar length during which they rest or do light work. The steel smelters and pitmen owed some of their excess also to these two causes, but even more to injuries (especially burns in the pitmen). Their heavy work comes in occasional bursts, alternating with long periods of comparative rest. They not infrequently change their shirts after a bout of heavy work, and are often provided with shelters into which they can retire, while puddlers, as a general rule, have no such protection. (Table 4.) An investigation was also made into the records of sickness of a body of blast furnace men at Middlesborough, which produced much the same result—an excess of sickness from rheumatism and respiratory diseases. This was most marked among the barrow fillers and laborers, and would seem to be due to exposure to the weather. It was more marked than among the melters, puddlers and tinplate mill men, who carry on their occupation at high temperatures. These blast furnace men were living in a single area of the country so that it would not do to be too dogmatic but it would appear that work at normal temperatures in the open is more likely to cause rheumatism and respiratory diseases than work at high temperatures. The result of this investigation is therefore highly instructive, and gives some idea of the value of research of this kind into the incidence of occupational sickness.

Boot and Shoe Trade.—The other inquiries referred to are not yet complete, but for the boot and shoe trade some figures are available in regard to female lives which are particularly interesting, both because they afford some up-to-date information about a subject on which little is known, and because they differentiate between married and single women. The figures available agree with the common opin-

ion that women lose more days through sickness than do men. They bring out the interesting fact that, even omitting illnesses due to the puerperal state, married women up to middle age have a higher sickness rate from all causes combined than single women. The full explanation of this is not yet apparent, but doubtless it is partly due to the fact that home circumstances give married women greater inducement to prolong the period of sickness. Another interesting result was obtained by the division of the lasters and makers, finishers and clickers into "service" and "non-service" men. The service men were those who at any time had been on active service during the War, and as they were medically selected for war service, the non-service men might have been expected to show a higher sickness rate, as being less fit. But the facts obtained showed that in each of the three sub-occupations, the service men had the heavier rates of sickness, except in the age group 25-34. This apparent anomaly arose from the fact that the period for which the men were on active service was necessarily omitted from the analysis; hence a considerable number of men were included in the tabulation who through wounds or illness had become unfit for active service and returned to their ordinary occupation in a subnormal physical condition. Table 5 gives the rates of attack and sickness by age groups, for all causes combined. Space limitations forbidding the setting out here of the rates for each group of causes, Table 6 is given in which a useful device has been adopted, by means of which some idea can be obtained of their relative weight. This is the application of the method employed by the Registrar General for comparative occupational mortality returns. For this purpose the population is taken as distributed according to age in the following proportions:

TABLE 5.—SICKNESS IN VARIOUS OCCUPATIONS DURING THE YEARS 1915-1919: RATES OF ATTACK AND SICKNESS FROM ALL CAUSES COMBINED[1]

Occupation	No. of Attacks per Annum among 100 Members in Each Age Group				Weeks of Sickness per Annum among 100 Members in Each Age Group			
	16-24	25-34	35-44	45-54	16-24	25-34	35-44	45-54
Males								
Boot and Shoe Trade:								
(*a*) Service men								
Lasters and makers	35.41	28.09	30.71	41.99	107.5	98.5	137.7	250.5
Finishers	37.89	28.98	29.63	43.90	107.2	108.8	130.8	222.5
Clickers	34.12	26.25	26.63	41.49	99.5	104.8	104.1	117.7
(*b*) Non-service men								
Lasters and makers	33.22	30.56	24.92	26.28	108.9	114.7	87.7	101.9
Finishers	36.39	32.36	25.07	23.94	128.2	129.0	96.5	92.0
Clickers	30.32	33.81	24.06	22.46	110.2	133.2	89.0	81.5
Females								
Spinsters and widows:								
Boot and shoe trade	36.05	28.20	23.75	29.89	128.9	118.6	100.3	131.7
Laundry workers	17.80	19.55	16.25	31.10	72.7	86.2	92.5	167.8
Married women:								
Boot and shoe trade	39.41	31.82	30.36	35.74	164.0	133.3	143.5	139.4
Laundry workers	20.26	22.68	24.40	28.51	104.7	122.9	170.9	195.7

[1] Illness termed "disablement" in the National Health Insurance Acts, accidents, illness due directly to war, and diseases relating to the puerperal state are excluded.

TABLE 6.—SICKNESS FROM VARIOUS CAUSES IN STANDARD POPULATION BETWEEN THE AGES OF 16 AND 54 DURING THE YEARS 1915-1919 IN BOOT AND SHOE AND LAUNDRY TRADES[1]

Occupation	Number of Attacks per Annum: All Causes	Influenza	Phthisis and Tuberculosis	Rheumatism	Respiratory Diseases	Circulatory Diseases	Digestive Diseases	Nervous Diseases	Skin Diseases	Other Causes	Weeks of Sickness per Annum: All Causes	Influenza	Phthisis and Tuberculosis	Rheumatism	Respiratory Diseases	Circulatory Diseases	Digestive Diseases	Nervous Diseases	Skin Diseases	Other Causes
Males																				
Boot and shoe trade:																				
(*a*) Service men																				
Lasters and makers	302	63	11	28	47	17	55	19	32	30	1,222	155	127	113	228	92	189	104	97	117
Finishers	312	65	11	35	46	18	57	20	31	29	1,192	161	103	158	188	73	203	84	87	135
Clickers	284	66	16	19	40	9	56	24	27	27	950	157	109	58	131	53	148	117	75	102
(*b*) Non-service men																				
Lasters and makers	267	77	13	24	42	13	41	11	25	21	946	198	125	79	163	55	123	44	75	84
Finishers	277	63	15	25	48	16	43	13	28	26	1,044	176	128	81	181	71	152	65	89	101
Clickers	259	80	16	18	47	12	32	12	19	23	971	210	155	57	183	51	112	52	55	96
Females																				
Spinsters and widows:																				
Boot and shoe trade	271	73	5	13	33	22	59	19	21	26	1,086	225	42	49	147	112	227	85	78	121
Laundry workers	182	40	6	14	32	16	24	9	13	28	873	123	55	92	130	88	121	45	49	170
Married women:																				
Boot and shoe trade	314	71	5	18	46	27	76	23	18	30	1,325	246	38	94	197	134	294	108	65	149
Laundry workers	211	39	4	3	30	25	29	10	11	40	1,265	212	27	151	180	160	167	79	46	243

[1]Illness termed "disablement" in the National Health Insurance Acts, accidents, illness due directly to war, and diseases relating to the puerperal state are excluded. The standard population is one-hundredth of that used by the Registrar General.

ages 16-24, 29,054; 25-34, 26,259; 35-44, 20,407; 45-54, 14,748. For convenience one-hundredth of these figures has been taken as the standard population in Table 6.

Recommendation

This brief statement of what has been attempted shows how promising is the field of research indicated. The interests of the health of the industrial community demand that a systematic attempt be made to obtain the facts relating to the incidence of occupational sickness. To measure the results of such investigations, standard tables of sickness are periodically required in which age groups and sex are distinguished. The records accumulating in the large general "approved" societies under the National Health Insurance Acts with membership running into hundreds of thousands, or even millions, of lives would furnish such a standard fairly representative of the industrial population of the country. It is the more to be regretted, therefore, that the exigencies of national finance have compelled the postponement of some and the abandonment of other of the trade sickness investigations contemplated by the Industrial Fatigue Research Board.

It is evident that little further help can be expected from government sources even for such a promising inquiry. Representatives of both employers and employed must interest themselves in the utility of such investigations which bear so closely upon both the efficiency and the comfort of the worker, by the creation of joint bodies charged with research into the general question of the human element in their respective trades, of which sickness incidence forms by no means an inconsiderable part. As the *Lancet* has recently pointed out, "The health of its people is the first care of every industry; this assured, other profits will follow."

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10. Vernon, H. M.: Fatigue and Efficiency in the Iron and Steel Industry. Rep. No. 5, Indust. Fatigue Research Board, H. M. Stationery Office, 1920.

BOOK REVIEWS

Health Service in Industry. By *W. Irving Clark, Jr.*, M.D., F.A.C.S., Service Director, Norton Company, Worcester, Mass.; Lecturer on Health Administration in Industry, Harvard Medical School; Assistant Surgeon, Memorial Hospital, Worcester, Mass. Cloth. Pp. 168. New York: The Macmillan Company, 1922.

Dr. Clark has presented in this book his conception of methods for the proper organization of an industrial medical department and its auxiliary services. It is the fruit of many years of experience in the administration of a notably well conducted industrial medical department.

Eleven chapters of about fifteen pages each deal with such questions as medical organization in large and small factories; factory dispensaries; industrial medical personnel; physical examinations; accidents and their treatment; industrial morbidity; and factory sanitation. Each subject is considered briefly but with precision. There are many useful tables of equipment and suggestive graphs. As stated in the preface, the author has not attempted to discuss more than one approved method of doing a thing.

Brief and simple, written essentially for industrial executives or physicians entering industrial practice, it is a much needed and excellent contribution to the literature of industrial hygiene.—*Wade Wright.*

The Prevention and Relief of Heart Diseases. By *G. A. Stephens*. Pp. 91. London: A. H. Stockwell, 1921.

The author of this little book takes cardiac disease as a text from which to speak of the value and importance of medical supervision in industry. He is a physician busy in the important industrial center of Swansea, and his book bears evidence of a running pen and of hurried proof correction. Notably on page 43 figures appear which can only puzzle the reader until he perceives that they are printer's errors; while on page 49 the population of Great Britain is stated as 20,000,000 instead of 47,000,000. These minor details should, however, be overlooked in view of the good work done in drawing attention to the extent and importance to national economy of the problem of heart disease; to the fact that many so-called "heart cases," which are now relegated to the industrial dust heap, are capable of productivity if fitted with suitable occupation; and to the need for employers to co-operate in rehabilitating such cases, and so benefit themselves, the workmen and the nation at large.

Dr. Stephens speaks highly of the work set on foot in America by the Association for the Prevention and Relief of Heart Disease, especially with regard to trade schools for cardiac convalescents; he calls for similar effort to be undertaken in Great Britain. He is insistent that cases of impaired cardiac capacity need, not idleness, but activity within their capacity, and that occupational therapy, properly controlled, is the most valuable of remedies; while "from a national point of view it must be worse than useless if we prolong the life of drones rather than re-create units of useful productive capacity."—*E. L. Collis.*

Prevention of Malaria in the Federated Malay States. By *Malcolm Watson*. London: John Murray, 1921.

This book, which is a record of twenty

years' progress in the prevention of malaria, is one of great interest to those whose work lies in tropical areas. The author brings out clearly how every district presents its own peculiar problems in this matter. Incidentally, he draws attention to the importance of health from an industrial point of view, particularly with relation to wastage of a labor force. The Malay estates are worked chiefly with native labor attracted from abroad, especially from India, and Dr. Watson states that "while coolies remain on an average three years on the healthier estates, they remain only two years on the unhealthy estates." This extra year on the healthy estates means an increase of the labor force by 50 per cent., and more than a 50 per cent. increase in the work done; for the coolie, at the end of his two years, is a skilled workman, especially when he is tapping rubber. Malaria is, therefore, an economic factor of great importance. We have here an excellent example of a fact which is often maintained, namely, that wastage of labor has a very definite relationship to health.—*E. L. Collis.*

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Lehrbuch der Grenzgebiete der Medizin und Zahnheilkunde für Studierende, Zahnärzte und Ärzte. By Prof. Dr. O. Büttner; Prof. Dr. G. Finder; Prof. Dr. E. Fuld; Prof. Dr. F. Grossmann; Prof. Dr. A. Gutmann; Dr. E. Herzfeld; Ministerialrat Obermedizinalrat Dr. F. Kölsch; Geh. San.-Rat Dr. H. Kron; San.-Rat Dr. R. Ledermann; Dr. J. Misch; Dr. H. Mühsam; Dr. G. Tugendreich. Edited by Dr. *Julius Misch.* Paper. Vol. I, pp. 691, with index, introduction, and illustrations. Vol. II, pp. 672, with index, introduction, and illustrations. Leipzig: F. C. W. Vogel, 1922.

Opiate Addiction: Its Handling and Treatment. By *Edward Huntington Williams,* M.D., formerly Associate Professor of Pathology, State University of Iowa; Associate Editor of the Ency. Brit. (Tenth Edition); Assistant Physician, New York State Hosp. System; Special Lecturer on Criminology and Mental Hygiene, State University of California; Author of "Mental Hygiene," "The Walled City: A Story of the Criminal Insane," "The Question of Alcohol," etc. Cloth. Pp. 194, with index and introduction. New York: The Macmillan Company, 1922.

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THE INDUSTRIAL HYGIENE OF FUR CUTTING AND FELT HAT MANUFACTURE*

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INTRODUCTION

THE making of felt is centuries old. Oriental shepherds are supposed to have discovered accidentally the felting property of wool when subjected to heat and moisture and gentle pressure. It was known to the Greeks; Pliny says the Gauls made a felt so strong that it would resist a sword stroke, especially if they used vinegar in making it. Saxon writers mention "fellen haets." According to the legend, St. Clement the Roman, patron of the hatters, once on a pilgrimage lined his sandals with wool to ease his feet and found that the heat and sweat and pressure had formed a sandal of felt. For long ages the primitive method of making felt hats persisted and may be seen even now in China. Fur, cut from the skin by hand and blown up into the air by the vibrations produced by striking a bowstring, fell over a cone-shaped form and was covered and pressed with a wet cloth. These processes now are carried on by machines, almost all of American invention, and so to a certain extent are the subsequent processes of shrinking and hardening the felt and shaping and smoothing the hat, although hand work still persists in some of the most modern factories where it is held that no machine can take the place of the trained hand of the sizer or blocker or pouncer.

The features that have given to the felt hat industry its reputation as one of the worst of the "dangerous trades" are the presence of great quantities of fine fur in the air of workshops and the use of acid nitrate of mercury as an aid in the felting of fur.[1] The fine hairs which form the fur of rabbits' skin and of the skin of hares, muskrats, beavers, etc., are smooth, resilient, and straight. Treatment with some chemical which makes them limp, twisted, and rough greatly aids in the felting process, and many chemicals have been shown to produce such an effect. Among them is the acid nitrate of mercury now used in the preparation of hatters' fur in all countries, with the possible exception of Russia.

*This is the first of a series of six articles, which are to appear in THIS JOURNAL, dealing with various phases of felt hat manufacture. Received for publication Feb. 28, 1922.

[1] The making of wool felt is not accomplished by the use of nitrate of mercury and is not included in this study.

This method has rooted itself deeply in the industry during more than two centuries. It has been traced back to the middle of the seventeenth century when it was a secret in the hands of a few French workmen, evidently Huguenots, for at the revocation of the Edict of Nantes in 1685, when the Huguenots fled to England, they carried the secret with them, established the trade there, and for almost a century thereafter the French were dependent on England for their felt. In France the fluid was called and is still called *le secret*, the process *sécrétage*, the workers *sécréteurs*, but in English-speaking lands the words carrot, carrotting, and carrotters are used because when white skins are thus treated and heat-dried they take on a carrot color. The formula used is still more or less a secret, although probably the proportions of mercury and nitric acid do not vary much. The French formulae, some of which are used also in this country, are said to call for the addition of white arsenic, As_2O_3, and of mercuric chloride. Arsenic has also been found in the water of a sizing kettle in England. The trade is classed as dangerous above the average in European countries and bears an especially bad reputation in France, Belgium, and Russia.

This report is the first of a series of articles describing an investigation of the hatters' furriers' trade and of the making of felt hats in the United States and in Europe—an investigation undertaken by the Division of Industrial Hygiene of the Harvard Medical School in 1921 and 1922.[2] The felt hat industry is a very important one in the United States and several fairly extensive studies have been made of conditions in American workshops and of the health of the men and women employed. The earliest studies were made in New Jersey in 1860, 1878, and 1886, and it is the New Jersey Department of Labor, under Commissioner Lewis T. Bryant, which has done the most efficient work in the sanitation of the industry. The establishments in New York, chiefly in and around New York City, have been investigated by the state factory inspection service and more recently by the New York City Department of Health. Finally, the National Civic Federation made a study of industrial mercurialism and in 1912 published a report of 102 cases, the majority of them having their origin in the felt hat industry of Brooklyn, Yonkers, Newark, and Orange.

From the perusal of these reports, especially the two last, one gains the impression that felt hat making is a trade with far more risk of occupational disease than the average, and this impression is strengthened by the attitude of the chief industrial insurance companies, which, as we shall see later, class as undesirable risks a number of groups of workmen in this trade. Yet it is hard to substantiate this impression by visits to the hatting centers and by interviews with employees and with doctors. Danbury, for instance, is practically a single industry town; the physicians there all have hatters among their patients. I interviewed ten physicians who had been in practice from three to thirty-five years and, though their opinions varied, none of them believed that the effects of the trade as now carried on were serious. The workmen with whom I talked had much to say of the unhealthfulness of the trade years ago, but the improvement of late had been so great as to make them feel that the industrial insurance companies were unreasonable in classing them as bad risks.

The work was made possible by the generosity of an anonymous donor

That mercurialism is a danger in the hatters' trade is denied by nobody, although opinions differ as to its frequency and its seriousness, but concerning the second conspicuous feature of the industry, animal dust, there is most contradictory evidence. Dust, consisting of fine fur particles and sharper, harder hair particles, is present in abundance in the earlier processes and to it is added, in the later stages, fine silicon dust, produced by rubbing the formed hat with emery paper to smooth it. There is no difference of opinion in regard to the harmfulness of the silicon dust, but decided difference with regard to the fur and hair dust, some authorities assuming that it is by its nature harmful and that, therefore, the enormous quantities produced in certain processes must constitute a serious danger, others declaring that they can find no evidence of injury among men and women working in these processes.

With this conflicting evidence before us, it seemed worth while to undertake a thorough study of a typical hatting town and of the men actually employed in the trade. It was hoped at first to include Orange, New Jersey, in the study, but work was so slack there that nothing could be done, and we had to confine ourselves to Danbury, Connecticut. The inquiry, as planned, fell into six branches:

1. Description of the processes of felt hat manufacture and of the conditions in workshops in the United States and in Europe.

2. Industrial diseases of hatters as described in the literature and their prevalence in different countries.

3. Physical examination of typical groups of working hatters with X-ray pictures of their lungs.

4. Examination of dust and vapors in the air collected in different departments.

5. An experimental study of the process of felting in order to see if some non-poisonous compound can be substituted for the acid nitrate of mercury now almost universally used in the preparation of fur for felting.

6. Analyses of fur from different departments in order to discover at which stages there is a loss of mercury, for in this way it will be possible to ascertain the departments in which the risk of mercurial poisoning is greatest.

Description of the Preparation of Fur and of Hat Manufacture

The felt hat industry is divided into three parts, although all three may be carried on in one plant and two very commonly are. First comes fur cutting, which includes the preparation of raw skins for carrotting (treatment with nitrate of mercury), carrotting, drying, brushing, cutting fur from the pelt, sorting the different grades of cut fur, packing it in paper bags, and blowing raw and carrotted fur.

This branch is unorganized and manned very largely by foreigners. It does not require an expensive equipment and many of the fur cutting shops are small and very cheaply built and managed. Sometimes fur cutting includes reclaiming waste fur of all kinds and waste felt from hat factories.

The second branch is hat making or "back shop" or "wet work," which begins with blowing and includes forming, hardening, sizing, and the multitude of processes for shrinking and shaping the felt. It may also include what is called preliminary pouncing—that is, rubbing off hairs with fine sandpaper.

The third branch is hat finishing or

"front shop" or "dry work," which includes dry blocking, shaping, final pouncing, and pressing (finishing), and also stitching, banding, trimming, etc.

In the description of the processes of felt hat manufacture no consideration will be given to any aspect of the work except the hygienic. The different methods are discussed only with regard to their effects upon the health of the men and women who use them, without any consideration of the excellence or inferiority of the product. It may be that the features of Italian, Czecho-Slovak, and British plants, which aroused my admiration, are regarded with contempt by American hatters as producing an inferior felt, but it is the worker who is under consideration in this report, not his product.

It would be unfair to make any general statement about this industry in the United States without qualifying it, for there are always at least a few shining exceptions to every indictment one is forced to bring against the industry as a whole. While fur cutting plants are usually poorly built, crowded, dark, ill-ventilated, and almost incredibly dusty, there are several which are well constructed and well managed and which compare favorably, in every respect, with the best in Europe. This is especially true of a large factory in Philadelphia, where all the branches are carried on under the same roof, and of two in Brooklyn, and one in Danbury. Standards, on the whole, are lower in Connecticut than in New York, and not quite so high in New York as in New Jersey.

Hat making plants require a much larger outlay of capital, they are better constructed and employ a much higher class of labor. Much more ingenuity has been expended in the effort to do away with the sources of danger and of discomfort in this branch, yet the difficulties are great and often they have not been surmounted. It is very common to find the blowing room thick with dust which flies through the air and lodges on every surface, and the forming and sizing departments full of steam, the floors awash, and water dripping from the ceiling. Hat finishing is, on the whole, less troublesome, and conditions in the trimming rooms are usually good—often excellent—but the pressing and pouncing departments are among the most dangerous in the industry, and here the safeguards may be very inadequate.

In comparing American with European plants, one finds that the advantages are not all on one side. French fur cutting has some features better than those in Danbury but at least one which is worse. English hat manufacture is superior to American in one department only—the forming room. The factories that I visited in Italy and in Czecho-Slovakia were vast in construction, especially those in Italy, with more than ample space, so that any air-contaminating substance is greatly diluted. My visits to these factories were made during the great heat of July, 1921, yet I suffered less discomfort than I had in Danbury in April and in May. In both plants cool air was driven into the heated rooms with so strong a draft that it blew one's clothing about. The windows on the sunny sides were covered, either with heavy linen curtains or with Venetian blinds. Steam from boiling kettles and tanks was removed more efficiently than in the great majority of American plants, and the work in the forming rooms was dry and easy while in American plants it is wet and heavy. The drainage of floors in American plants always leaves something to be desired, usually a great deal.

In the Borsalino factory, in Alessandria, the cement floors in the wet rooms are stamped in squares with deep lines so that the feet will catch and not slip, and this permits a much steeper slope to the floor than is possible with smooth cement.

The care of the individual workman has never been a responsibility of the employer in this industry in the United States. It is customary to provide long rubber gloves for the carrotters, but other working clothes, as well as soap and towels, must be provided by the workman. In France, Germany, Great Britain, and Czecho-Slovakia, all men and women who handle fur after it has been carrotted must be furnished full suits of working clothes, including caps, and in Italy, although the law does not require it, I found it done in the Borsalino factory, and in Valera and Ricci's, near Milan. Medical inspection of all workers exposed to mercury is required in these countries, with the exception of Italy. It does not seem to be provided in any American plant.

The description given here is not technical; it deals with the various processes only so far as is necessary in order to demonstrate the unhealthful features, if there are any. For a thorough, expert report on the technical problems of ventilation, steam, fume, and dust prevention or removal, lighting, etc., the reader is referred to the very complete report compiled by Miss Lilian Erskine (1) for the New Jersey Department of Labor, and published in 1915, under the title *Sanitary Standards for the Felt Hatting Industry.* Models of exhausts, hoods, etc., may be seen in the state Museum of Safety in Jersey City.

Fur Cutting

Raw Skins.—The handling of raw fur is filthy work; the odor is very disagreeable and rarely is any effort made to lessen the unpleasantness. The skins are in sleeve form as they come from the trappers who pull them off as one pulls off a glove. They are first dampened, then cut open, cleaned with knives, stretched, cleaned in tumblers with sawdust, or carded with a wire brush, and then the long stiff hairs must be removed for they will not felt. Hand plucking or pulling is considered by far the best way to get rid of these hairs, but it is done on a large scale only in Belgium, and Belgian hand-plucked skins are sold to the trade all over the world. In America, machine plucking is done and the long hairs from beaver and nutria skins are sometimes plucked by hand, but the common method of ridding the skin of hairs is to put it through a shearing machine and cut off as much hair as possible without injuring the fine fur. This shearing may be very dusty, as, for example, in one Brooklyn plant, where the air was choking and the machines, the windows, and all surfaces were thick with dust. On the other hand, this same department in the Mutual Fur Cutting Factory in Danbury was beautifully clean.

It seems to be generally assumed that this fur dust is dangerous and must be removed. In Hückel's factory in Neutitschein, each bench for machine plucking is furnished with an exhaust, and I saw an equally good arrangement in Jonas and Naumberg's plant in Brooklyn. How important it is to remove the fur dust in these raw fur departments it is impossible to say until we know more about the effect of such fur on the respiratory tract.

Carrotting.—The application of mercuric nitrate, or carrotting, comes next and may be effected by hand or by ma-

chine. The hand worker dips a stiff brush into the solution and scrubs it vigorously into the fur side of the skin. The machine operator passes a raw skin under a revolving brush which dips down into the "carrot" and then runs over the fur. There does not seem to be much difference between the two processes unless it be that the hand carrotter is more exposed to fumes. His advantage, however, is not great since, although the machine for carrotting is covered, there is often a fine spray from the brush. The machine operator carrots 5,000 to 6,000 skins a day and piles them up on a bench and on the floor around him; the hand carrotter can finish only about 2,000 a day. The men protect their hands with rubber gloves, their forearms usually with stocking legs, and they often wear a pad of felt or wool over the chest and abdomen.

In the Stetson plant in Philadelphia, there is an excellent carrotting room on the top floor with windows on four sides and in the roof. Both machines and hand work are used and the machines are hooded and provided with suction exhausts. This is not true everywhere and local exhausts are rarely seen on benches for hand carrotting. The best I have seen is in Hückel's factory; the opening, 7 inches high, runs along the back of the bench and a proof that the draft is good is seen in the fine fluff of fur over the wooden grating which protects it. The advantage of a fairly equable climate is seen in one of the French fur cutting plants, where all the carrotting is done in an open courtyard, covered with a glass roof. In our northern states, this would be freezing cold in winter and unbearably hot in summer.

One special kind of carrotting is a bad feature in most plants that use it. This is the carrotting of fur scrap in tanks, often uncovered, then centrifuging off the fluid and spreading the fur about to dry in the open air.

Carrotting fluids differ in different countries and in different factories in the same country. Heucke (2) gives the formula in general use in Germany as follows: mercury, 20 parts; nitric acid, 80 (40-36 Bé diluted to 11 Bé). Yellow carrot has more nitric acid, white more mercury. According to Montagné (Thèse de Paris, 1901) the formula generally used in France for carrotting is mercury, 8 parts; nitric acid, 64 parts; white arsenic and mercuric chloride, each 4 parts; the whole diluted with varying quantities of water. Chaplet (3) says that the French use for white carrot: mercury, 40 gm.; nitric acid (36 Bé), 125 gm.; water, 1 liter. Monti (4) says that the Italians use 32 parts of mercury to 100 parts nitric acid (36 Bé) for white carrot; for yellow, 16 to 20 parts of mercury to the same amount of acid, both diluted with water. The carrot used in New Jersey, according to Miss Erskine, is mercury, 20 to 30 pounds; nitric acid, 100 pounds, diluted with 20 volumes of water. Stetson's procedure is as follows: 19.69 per cent. mercury, 31.79 per cent. nitric acid (58 Bé). This, diluted to 13 Bé results in: mercury, 4.28 per cent., and nitric acid, 6.89 per cent., which is the strength actually used in carrotting.

Drying.—It is in drying that more than half the mercury is said to be lost by vaporizing. Heaps of freshly carrotted skins are carried on men's shoulders to be dried with heat for yellow carrot, or at ordinary temperature for white carrot. Americans use about 80 per cent. of yellow carrotted furs, and 20 per cent. of white, the European procedure being just the reverse. For yellow carrot, the usual way is to dry

Known as the "carrot."

the skins in great "stoves," which are iron-enclosed rooms containing a series of heated shelves; in some factories each shelf has its own long, narrow opening closed with a metal flap. The skins are spread on long trays, then pushed in on the shelves, and after an hour or so drawn out through the narrow opening. This is a good arrangement, much better than wide doors; nevertheless, the great tray of hot skins is undoubtedly a source of mercurial fumes which are breathed, not only by the men who tend the stoves, but often by the carrotters as well, for the stoves are often in the carrotting room. A decidedly worse method is to place the skins on racks and provide the stoves with wide doors through which the racks may be pushed in and pulled out. The best arrangement of all is to be seen in some New Jersey plants. It is essentially an endless wire apron passing slowly along over steam pipes, with a narrow opening for a feed door, an automatic discharge, and an in-draft to prevent the escape of fumes.

White carrot is sometimes dried over the stoves, but usually in a separate room at ordinary temperature, the skins being hung or spread about a large room which sometimes opens into a working room. There seem to be different theories with regard to white carrot. In one plant, air is driven into the room by fans, in another no ventilation is allowed, for it is held that the skins must dry in still air.

Storing.—Before storing, the dried skins must be dampened and this work is often done by women. All who handle the carrotted skins show deep yellow stains on the hands, and it is inevitable that they should inhale volatilized mercury. The storage rooms in which the skins are stacked for varying periods to "ripen," sometimes for many months, are often in the basements of the building and poorly ventilated. The work of the storage room man, filling and discharging the great wooden slatted bins, is regarded as undesirable, even by the most optimistic employer. Storage rooms should be quite shut off from workrooms, but I have seen them opening—and the doors open at the time—into the fur-mixing room, into the brushing room, and in one case storage room and carrotting room were the same. Since wood absorbs mercury, the New Jersey Department of Labor advises against its use in the construction of storage rooms.

Brushing.—Brushing the carrotted skins is usually done by machine. Obviously, from this time on, dust is a much more serious item than it is in the raw skins department, for it is now laden with mercury. The man, or more often woman, brusher, usually works at a bench with a pile of carrotted skins lying on an iron shelf under which is the brush. She holds the skin against two rolls which catch it, carry it over, brush it, and bring it back again to be pulled out. These women have yellow stains on their hands. The dust may be carried off by exhausts if the brush is so arranged that it revolves away from the brusher, and this is sometimes true, but when, as in some factories, it runs toward the brusher the exhaust cannot catch all the dust and a fine fluff can be seen on the face of the brusher, especially on the chin.

Cutting.—The cutting machines are an American invention, very efficient and horribly noisy. This is by far the most trying part of a hat factory to the outsider, for the din made by the machines is almost intolerable. The cutter, almost invariably a man, feeds the skin into the machine which, by means of stationary and rotary knives,

shreds away the pelt and delivers the fur on a flat tray. Women sorters, sitting at a long table in front of the cutter, receive this tray. Their task is to remove bits of skin and tangled fur ("dags"), and then to sort the fur into different grades, the cheeks and feet forming the inferior, the center of the back the superior grade, except in the case of water animals, whose best fur is on the center of the belly. From three to five sorters work with each cutter. This is what is called in England "locking."

The shredded pelt, which looks like excelsior and is known to the trade as "noodles," is gathered up from the floor and, if there is a good deal of fur clinging to it, it is shaken violently, a dusty procedure, which should not be allowed, and which is not necessary because a well-set cutting machine will deliver very clean noodles. The final destination of the shredded pelt is a glue factory.

The fluff in the cutting room is seldom abundant but is very fine and can sometimes be seen on the women's hair or on the caps they usually wear to protect their hair. But conditions in cutting rooms vary greatly in this respect. In the Mutual Fur Cutting Factory in Danbury the sorters are all Syrians, and I could see no dust at all on their shining black hair. Work in the cutting room is not considered as bad as in subsequent departments where steam is a prominent feature, and this impression is doubtless justified since the mercury volatilizes less in the absence of heat.

Storing Fur.—The women sorters weigh the cut fur and pack it in paper bags, which go to the storage room for cut fur, another notorious source of mercury fumes and usually very poorly ventilated. In the plant of Jonas and Naumberg in Brooklyn, great pains have been taken to remove the mercurial fumes by driving in fresh air from above and applying suction exhaust below.

"Blown fur" is reclaimed fur, scraps pasted on paper and put through a cutter. It is mostly raw with a little carrotted fur. Ordinary fur is known as "cut fur," even if it has been already blown. For reclaiming, pieces of fur from garment shops are chopped and blown, "roundings" of felt from hat shops are bleached, chopped, and blown—all of which is dusty work, but largely free from mercury.

Hat Making or "Back Shop"

Mixing.—The fur from the cutting shop is mixed by hand or by machine and then goes to a "devil"—*i.e.*, a cone-shaped box with a fan bringing in a draft of air to blow the fur, and teeth which revolve and pick apart the fur so that the draft can catch it and mix the different varieties together.

Blowing.—This is almost always an excessively dusty process in American plants; indeed, I have seen but four which were fairly dust free. The blower is essentially a series of compartments, usually six, enclosed in fine wire netting and furnished with a travelling apron which feeds in the fur and with rapidly revolving pickers which catch it, pick it apart, and toss it in the current of air formed by their revolutions, letting the heavier hairs and the dust fall to a space between the apron and picker. This air, of course, passes out through the netting, and the amount of fur carried out depends on the rapidity of the revolution of the pickers and also somewhat on the quality of the fur, for if a great deal of short fur and "roundings" — *i.e.*, ground-up felt

trimmings—form part of the mixture, more will escape during the process of blowing. The fur tends to cake or felt over the inner surface of the netting and must be shaken down by beating on the outside, a procedure which is sometimes done by machine, sometimes by hand. It also cakes within the machine and the task of cleaning is very dusty.

Moisture is necessary to keep the fur from clinging together in masses, and this is commonly provided by jets of steam driven into the room through pipes placed at intervals. The combination of steam and choking dust makes the usual American blowing room a trying place. I have seen fur flying about as thickly as snow in a heavy snow storm, and in one Danbury plant the steam and fur had formed a solid felt coating over the windows. In a Brooklyn plant, the dust from the machines was increased by the use of compressed air to blow the accumulation of fur off the top of the apparatus. In such places, the men are covered with fluff—faces, hair, and clothing—and they chew tobacco constantly because the expectoration helps to get rid of the fur in the throat.

The great Stetson plant in Philadelphia has an excellent blowing room. The draft within the blowers is as strong as in other plants, but a heavy oilcloth hood with the glazed side under, curving over the blowers, prevents dust from escaping. Another excellent feature, which I have seen nowhere else except at Stetson's and in the Mutual Fur Cutting Factory in Danbury, is the delivery of steam into the machine instead of into the room, which means that far less steam is needed and that the air in the room is not so unpleasantly humid. In both these factories, mechanical beaters flap continually against the network to dislodge the dust.

European blowing rooms are far less dusty, they are freer from fluff than the best American, and yet the blowers are not covered. It seems to be a question of the rate of revolution of the pickers; the more rapidly they revolve, the greater the air current and the greater the escape of dust. Certainly, the blowing rooms in the English, Italian, and Czecho-Slovak factories which I visited formed a strong contrast to the usual American departments, although none had so good a humidification system as Stetson's and as Buzaid's. In one of the Italian factories, Valera and Ricci at Monza, no humidification at all is used; they do not find it necessary in that warm climate.

The New Jersey Department of Labor believes that humidification is greatly overdone in most factories, that it is quite unnecessary in warm weather, and that the usual 65 to 75 per cent. humidity is needed only in cold weather when the fur is full of electricity.

Forming.— The ingenious machines used for forming in every country are of American invention. Blown fur is weighed by girls into quantities sufficient each for one hat. The girls stand at the back of the former (the machine is known as the former, the operator as the coner), and a traveling belt carries the weighed fur to a great cylinder where it meets a picker which picks it apart. It then meets jets of steam which warm and moisten it; then a strong current of air catches it and sucks it down over a perforated brass cone which is placed on a turn-table in a chamber at the end of the cylinder. This forms an even, loosely compacted layer of felt over the copper cone about three times as large as is desired. The coner opens this chamber—and a puff of dust always escapes as he does so throws a burlap wrung out of boiling

water over the cone and its delicate fur covering, fits a similar cone over it, lifts them off and plunges them into a tub of boiling water which stands beside the former.[1] This gives the fur cone its first shrinking and it can then be lifted off, wrapped in burlap, and given to the hardener who slips it over hand and arm or spreads it on a bench, examines it for flaws, "stops" the weak places with fur and picks out dags. The hardener then puts about a dozen cones together, sprinkles them, kneads them with his hands for the first hardening and sends them to the sizing room where the 30 to 35-inch cone is gradually shrunk down ("sized") to about one-third and changed from loose delicate felt to a hard, even structure.

The work of the coner is very hot and heavy, and practically incessant. The air, even in the best ventilated rooms, is full of steam and the floor streaming with water. Analyses of the air from the formers have shown the presence of mercury, volatilized by the steam, and to this air are exposed not only the coners but also hardeners and girls employed in weighing batches. These girls are almost always stationed where heat and humidity are worst, right under the ceiling. I was impressed by the arrangement in Borsalino's factory, where the girls weighing batches work in the room above the former, dropping the batches through a small opening, whence compressed air delivers them to the machine below. An electric light signals for each batch.

In one Brooklyn plant, the discomfort in the forming room is increased by driving jets of live steam into the room. The suction inside a former is very great and unless the room is amply large air must be drawn in from another room and, as a usual thing, it is drawn from the sizing room, laden with steam and heat. The humidity may reach saturation, yet it is quite unnecessary. The escape of fluff from the former is always visible and in one badly neglected factory in Danbury the windows of this room are covered with felt.

Forming is less strenuous and far less disagreeable in Europe. The reason is that the hot water, needed to give the cone of delicate felt its first shrinking, is applied within the former by means of a long jet of water which plays evenly over the surface of the revolving come just before it is taken out. Then all the workman has to do is to open the former, gently lift off the cone of felt, fold it together for the inspector, and wait for the next one to form. There is no steaming tank, the floor is dry, there are no heavy brass cones to lift repeatedly, and the work is light and leisurely compared to the same work over here. This method was used in all the foreign plants I visited and was common in this country some twenty years ago. Another good feature was the vast size of these rooms in the European plants, providing air enough for the suction in the former.

Sizing Room.—After being inspected, the cone goes to the sizing room and there is put through a series of processes known as hand starting, wetting down, pulling out, sizing, blocking, wringing or whizzing, etc., all of which are essentially the same, consisting in the application of boiling water and pressure to shrink the felt down to the proper size and then to shape it. Sizing, whether by machine or by hand, is very laborious work and is carried on in an atmosphere of humidity and heat. The hand sizers (sizers may also be called "makers") usually work in

[1] Coners are sometimes divided into coners and "wetters."

groups of eight at an octagonal "battery"—that is, a tank of boiling water with a wooden bench running round it. The sizer first sprinkles several hats with boiling water usually acidulated with a small amount of sulphuric acid, kneads them gently with his hands, then as they harden he works them more vigorously and plunges them into the water, cooling his hands in a pail of cold water. Finally, he takes one hat at a time and beats it with a wooden rolling pin. He usually protects his hand partially by a leather or wooden shield over the palm. This is the work that the English call "planking."

Sizing machines are like large clothes wringers with wodoen rolls obliquely fluted, and the sizer alternately dips a bundle of cones in the tank of boiling water below the rolls and places them between the rolls. The sizing room is full of these boiling kettles and it is rare to find one which is not foggy with steam, water dripping from the ceiling and running in streams on the floor. Curiously enough, the water from the kettles which must be "pulled" twice a day is not emptied through separate drains but is flooded out over the floor to find its way through the gutters to the main drain.

Great efforts have been made in certain factories to control the steam in the sizing room by exhaust ventilation and by control of the temperature, for if the moisture-laden air comes in contact with cold air from open windows it condenses and a thick fog forms. Against a cold ceiling the fog turns to water and rains down on the heads of the men. The problem is excessively difficult in our variable American climate and success has been obtained only in those factories in which adequate exhausts are installed at the place where the steam is generated, for once it has been permitted to escape into the air nothing effective can be done to get rid of it. There is general testimony from the workmen as to a decided improvement in sizing rooms during recent years, but conditions in most of the plants outside New Jersey still seem productive of discomfort and fatigue, if not of mercurial poisoning. For instance, my notes on a Danbury sizing room read as follows:

As I went into the sizing room I walked into a dense fog. The windows were open, the day was chilly, about 58° F., and as all the boiling tanks are unprotected by hoods, the steam was rising, and when it met the cold from the windows it formed a fog. There are exhausts placed at intervals, supposed to carry off the steam, but I could not see that they did the slightest good. Streams of water were running over the floor, and, although the sizers stand on wooden platforms, they have to step down every now and then into the stream. They were sopping wet, the shirts clinging to their bodies, and water dripped on us from the ceiling. About 100 work here an eight-hour day. It is piece work and the pace is very rapid.

In one Brooklyn factory the sizing kettles are either quite unprotected or provided only with a suction pipe, the opening of which is too narrow to catch much of the steam. In Stetson's factory where a great deal of hand sizing is done, the kettles are very well protected by a circular hood with an exhaust pipe and with a curtain composed of flaps of heavy canvas which hang from the edge of the hood to the edge of the kettle, the sizer pushing the hat under the flap. This admirable arrangement prevents the escape of steam. Hückel's factory has the same arrangement. For sizing machines the devices in the Berg and No-Name factories in Orange are very efficient. A metal hood with an exhaust pipe fits

over the sizing machine, enclosing all of the kettle except for an opening in front just large enough to work through. Very much the same kind of hood is used in Borsalino's factory, and here an excellent feature is the rough cement floor sloping well to the drains and the efficient control of the temperature by big registers in the floor through which delightfully cool air is sent in summer and warm air in winter.

Stiffening.—The majority of hats made in American factories are soft felt but require some stiffening. This process is of no importance from our point of view for the stiffening compound is simply shellac dissolved in hot water, borax, and common salt, rubbed in with a brush, and then steamed to melt the shellac and drive it in. For stiff hats (this word is applied only to derbies) the procedure is different. The hats are first shaved by a machine like a small lawn mower which clips off the ends of those hairs that have escaped the blowing process and become incorporated in the felt. The fine harsh dust of shearing is generally considered decidedly harmful. The stiffening department is usually quite separate because of fire risk from the vapors of alcohol used to dissolve the shellac. Denatured alcohol is used with varying quantities of wood alcohol according to the formula selected, for the revenue law allows from 4 per cent. to 20 per cent. of wood alcohol in the mixture. Up to 1906, straight methyl alcohol was always used for stiffening and it was largely through the efforts of the Danbury hatters, backed by the physicians in Danbury, that the law was passed by Congress providing for revenue-free denatured grain alcohol. This has brought about a vast improvement in the stiffening of felt hats, but it must not be forgotten that denatured alcohol is not free from danger. The addition of as little as 2 per cent. of methyl alcohol has been known to lead to characteristic poisoning (Loewy and von der Heide, 5) and the formula commonly used for stiff hats contains as much as 10 per cent. It is well known among stiffeners that some men cannot stand the fumes even of the denatured alcohol, although others are not affected at all. Drying these hats may be a source of danger for mercury has been found in the course of recovering the alcohol.

Dyeing.—Dyeing may be done at several different stages. For mixed colors the blown fur must be dyed before the cone is formed, but this makes sizing more difficult and is not used for solidly colored hats. A method which is very objectionable to the men has recently been revived in Danbury after many years' disuse. This is known as "mucking" and consists in the addition of the coloring matter to the water in the sizing kettle so that the sizers must work continuously in hot dye. The men say it makes the ends of the fingers sore, that hang-nails inflame and fester, and that scratches become very painful. They also believe that the steam from the sizing kettles carries with it unpleasant, if not harmful, fumes. The vegetable dyes which were formerly used have now been displaced completely by coal-tar dyes belonging chiefly to the azo acid group (Naphtol Blue Black and Naphtol Black B). It is highly improbable that harmful fumes could come from these dyes but there is one dyestuff, known to the trade as ursol, which is distinctly toxic and is used in some hat factories. This is para-phenylenediamine, a compound which has the toxic properties of the amido group of coal-tar derivatives and can be absorbed both through the skin and the respiratory tract, the absorp-

tion being hastened by heat and moisture. In color manufacture and in dyeing fur this compound is notoriously troublesome, causing a distressing trade eruption and, in susceptible individuals, attacks of bronchial asthma (6). Dermatitis has also occurred in persons wearing fur which had been colored with para-phenylenediamine (7).

The ordinary way of dyeing is to color the shaped and stiffened hat, and a chrome mordant is often required, potassium bichromate being generally used. This is admittedly a source of some trouble in the dyeing room. Chrome ulcers, slowly forming and painless, may develop on the ends of the fingers around the nails, on the nasal mucosa, and sometimes on the margins of the lips. There may also be a severe conjunctivitis. Both mordant and dye may be applied in open kettles, stirred by hand with long wooden rods, or in closed kettles, agitated by a stream of air, or in closed revolving cylinders which dip down into the dye at each revolution. According to the method used, conditions vary in the dyeing room and all extremes may be found in American factories from a Danbury plant in which only hand work is done over open tubs in steam and drip, to the model department at Stetson's, dry and airy, with its closed cylinders for hats, its closed kettles for fur, and no escape of steam anywhere. Second sizing by machine may follow dyeing.

Pouncing.—Pouncing is the name given to the smoothing process in finishing both soft and stiff hats which is done with the finest of emery paper by hand or by machine. The pouncing of soft hats is much more extensive and productive of much more dust than the pouncing of stiff hats. It comes before finishing and the men are called "pouncers," while pouncing stiff hats is a part of finishing and these men are known as "finishers." The soft hat finisher may do a little pouncing, but not much. An exhaust is always furnished to carry off the dust and, in the case of the pouncing machines, it is usually quite efficient. These machines are used on brims, the narrow brim being held between two sandpaper-covered surfaces. The man's hands are outside, consequently only a narrow opening is necessary, and the construction of shield and exhaust presents no difficult problem. But crown pouncing is almost always done by hand, and obviously it is much harder to prevent the escape of dust over this larger surface which cannot be so completely enclosed. The best device I have seen was in a New Jersey factory and may be seen in the Museum of Safety of the State Department of Labor in Jersey City. After pouncing, comes "rubbing off" of tips and brims with sandpaper, which is the same as pouncing, except that the block on which the hat rests moves back and forth instead of round and round.

To the uninitiated the amount of dust produced by pouncing seems insignificant, and yet enough of it is collected by the exhaust pipes to ship to fertilizing plants. All pouncing, as I have seen it done, is more or less safeguarded, but there is a wide variation in the efficiency of the different mechanisms provided. The process is performed twice, preliminary pouncing and final pouncing or, as it is sometimes called, "crown jigging." Preliminary pouncing may be done in the back shop by the hat makers; final pouncing always belongs to the front shop, and is done by hat finishers. If the suction apparatus is poorly designed or the draft feeble, fine dark dust can be seen

on the face of the pouncer, especially in the folds along the sides of the nose and on the chin. It is always men's work in the United States, in England, and in Czecho-Slovakia, but is done by women in Italy, where only machines are used, no hand pouncing. Hückel's factory also uses machines altogether.

In two factories, one in Danbury and one in Brooklyn, the draft to carry off the dust worked badly, the fine dust lay thickly over pipes, shields of exhausts, floor, and over the persons of the men, and it was significant that these men all chewed tobacco to help rid their mouths of the dust. In some shops, there is a great deal of brushing of the pounced hats, which increases the dust, and whirling belts keep the dust stirring. Two exceptionally dust-free pouncing rooms may be seen in the Mallory factory in Danbury and in Berg's in Orange.

Hat Finishing or "Front Shop"

Finishing. — Finishing consists in steaming and blocking to give the crown the final shape, drying, pressing by hand, or in an hydraulic press, singeing, oiling, and pouncing. Hot oil and vaseline are used to even up the color, alcohol or naphtha singeing to finish the surface. The highest temperature to which hats are subjected is in pressing, and it is probably in this department that mercury is volatilized to a greater extent than in any after sizing. Moreover, the finisher must bend down close to the hat while pressing, putting himself in just the position to inhale these fumes. Several authorities hold that the exposure to mercurialism is greater in finishing than in any other occupation of the trade. This work brings in other bad features, such as carbon monoxide from naked gas jets, naphtha fumes, and silicon dust. The heat for the irons is usually provided by gas and the grease is heated over gas. Electric irons are used in some New Jersey factories and at Knox's in Brooklyn, but gas-heated irons are much more common. Shaping also is done on gas-heated machines and all these processes may be carried on in one room, together with the pouncing. Unless these rooms are very large, the heat may be excessive—up to or even over 100° F.—and in one New York plant, Graham-Rogers and Vogt found four parts of carbon monoxide to 10,000 parts of air. The men employed here, classed together as finishers, say that these jobs, although highly desirable because of the good pay, are the most unhealthful of all.

Beaver Hats.—The making of beaver hats is not attended with risk of mercurialism. Beaver hats are made from non-carrotted fur on a wool felt body. The raw fur (hares' fur, for it felts poorly), which is to give the smooth, shining finish to the hat, is first formed in a machine very like an ordinary former but with a disk instead of a cone. This flat form is then "batted" on to the wool body, the man working at a plank like a sizer's and batting with a stiff brush dipped in boiling water which contains sulphuric acid. Wrapped in burlap, the body then goes through apron rolls through which live steam is driven into boiling acidulated water, the acid being stronger here. Jets of hot water raise the nap and a curry comb finishes it. The acid in the water eats away the wood of the tanks and they leak, the floors run with water and the steam is excessive, but there is no mercury used and no pouncing needed. The sulphuric acid is hard on the men's hands, and they protect them by smearing on tallow, but this is a

minor evil compared to those found in ordinary felt hat manufacture.

For convenience, a list of occupations in fur cutting and in hat making and hat finishing with the hazards in each occupation is given in Table 1.

chines. All the final processes of stitching, lining, banding, and putting in leathers are carried on by the women, but these departments do not concern us. Boys are not often employed, although I have seen some apparently

TABLE 1.—SUMMARY OF PROCESSES IN FUR CUTTING, HAT MAKING, AND HAT FINISHING, WITH IMPORTANT HAZARDS OF EACH PROCESS

Process	Hazard
Fur Cutting	
Dampening raw skins.	Coarse hairs and dirt.
Opening up raw skins.	Coarse hairs and dirt.
Cleaning raw skins.	Coarse hairs and dirt.
Beaming and stretching.	Coarse hairs and dirt.
Plucking hairs or fur pulling.	Coarse hairs and dirt.
Shearing.	Coarse hairs and dirt.
Carrotting.	Fumes of nitric acid and of mercury.
Drying.	Mercury volatilized by heat. Direct contact with mercuric nitrate.
Storing carrotted skins.	Volatilized mercury, direct contact.
Brushing, cutting and sorting, weighing, and packing in bags.	Volatilized mercury, direct contact; fur dust.
Storing and removing from storage.	Volatilized mercury.
Blowing.	Dust; sometimes mercury.
Hat Making	
Removing bags from storage.	Volatilized mercury.
Weighing and mixing, blowing, weighing for former, coning, and hardening.	Volatilized mercury; fur dust; heat and moisture.
Starting, sizing, pulling out, blocking, whizzing.	Volatilized mercury; heat and moisture.
Preliminary pouncing.	Silicon dust and fine hairs; mercury.
Dyeing.	Heat and humidity; chrome mordants; coal-tar dyes.
Stiffening soft hats.	Heat and humidity, slight.
Shearing.	Hair dust.
Stiffening stiff hats.	Small quantity of methyl alcohol.
Hat Finishing	
Dry blocking, pressing in hydraulic machine, pressing with hot iron, singeing, final pouncing.	Carbon monoxide from gas; volatilized mercury; naphtha fumes; silicon dust and fine fur dust.

Women are found commonly in American factories handling the skins before carrotting, brushing carrotted skins, dampening them for storage, sorting the cut fur (rarely cutting), weighing and packing it in bags. They also weigh fur for the forming ma-

under 16 tending the drying stoves for carrotted skins. Young men in the late teens and early twenties are often found as sizers, especially in one large American factory, where some 200 are employed in this sort of work.

In European plants, women often do

cutting, inspecting, and pouncing, sometimes carrotting. As for young persons, the Belgian law of 1893 forbids the employment of anyone under 18 years in processes where nitrate of mercury is used, or in plucking or cutting if there is much dust. The French law of 1898 forbids the employment of any under 16 years in the fur cutting trade, and in 1899 the British prohibited the employment of children, who up to that time had apparently done what the British call locking, and we call sorting — *i.e.*, removing the inferior parts from the cut carrotted fur.

Industrial Insurance for Hatters and Fur Cutters

The three largest companies writing industrial insurance in the United States consider certain occupations in these trades of fur cutting and felt hat manufacture as distinctly above the average in danger to health, others as less dangerous, but unhealthful. Their selection of the undesirable ones, however, is not by any means the same. Thus, the John Hancock Mutual Life Insurance Company lists the whole industry, fur cutting and hat making, as doubtful, and the work of carrotting and of pouncing as extra hazardous. Fur cutters, hand carders, hand mixers, blowers, coners, wetters, hand starters, sizers, dryers, dyers, alcohol stiffeners, and foremen in these departments, are insured at rates above the ordinary.

The Metropolitan Life Insurance Company divides the employees into four classes, according to risk. In the ordinary class—that which has an expected mortality not over 20 per cent. in excess of the American Experience Table—are placed only the trimmers, welters and binders. Next, with an expected excess rate of 20 to 50 per cent., come all who are not listed in the other three classes. Special class jobs, with an expected excess rate of 50 to 100 per cent., include hand carders, blowers, hand mixers, hand starters, sizers and dyers. Special Class B includes those with an excess rate of 100 to 150 per cent.—fur cutters, carrotters, dryers, pouncers, and alcohol stiffeners.

The Prudential Life Insurance Company refuses to insure fur cutters, sizers, and makers. It accepts at increased rates: mixers, blowers, weighers, feeders, coners, wetters, hardeners, blockers, dryers, pouncers, singers, and trimmers; at ordinary rates: inspectors, finishers, shavers, curlers, flangers, stiffeners, and packers.

Summary

The trades of the hatters' furriers or fur cutters, of the hat makers and finishers have for centuries been looked upon as fraught with a high degree of danger to the workers. This impression prevails at the present day, especially in France, Belgium, and Russia.

The features of these trades which are regarded as dangerous are the use of mercuric nitrate to prepare the fur for felting, the handling of this fur in an atmosphere of heat and humidity which volatilizes the mercury and favors its absorption, the production of great quantities of fur dust and lesser quantities of silicon dust, together with minor evils, such as carbon monoxide from gas jets.

Fur cutting involves exposure to nitric acid fumes and volatilized mercury, and to excessive amounts of fur dust. Hat making is hot and wet, and the exposure to volatilized mercury is probably greater than in fur cutting. Hat finishing is dry, but the heat applied

in pressing volatilizes the mercury, and there are other bad features, such as silicon dust from emery paper, carbon monoxide from gas-heated irons and machines, and traces of methyl alcohol in the stiffening mixture.

The hygienic control of fur cutting shops in the United States is very imperfect, although there are a few brilliant exceptions to this statement. Hat factories have improved greatly of late, especially in New Jersey, but there are still many plants in which ventilation is poor, heat and humidity excessive, and the workers exposed to mercurial poisoning and to the inhalation of dangerous dust.

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TIME AND MOTION STUDY*

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Part I: Review of Past Work

INTRODUCTION.—Time and motion study has become a phrase of common occurrence in industrial circles; yet little agreement exists as to its precise significance and little understanding as to how, and to what extent, such a study can be of use to industry. Some consider that a little attention to the time taken to perform an operation, and the method of doing it, should be sufficient to "at least treble output." Others form a much lower estimate of the probable value of these methods and consider it presumptuous for an outsider to come into a factory to teach others how to do their work. The truth as to the function of the study probably lies somewhere between these two extremes, but it is more likely to approximate toward the latter than the former. To talk of trebling output may be useful for commercial purposes, as being likely to attract the attention of those anxious to improve industrial methods, but if taken literally it is most misleading. Anyone who has carefully studied the subject in any industry must be impressed not so much with the ease of effecting improvements as with the practical difficulty involved in so doing.

We may define time and motion study in the following manner: *Time study* is the study of the time taken to perform each particular operation in an industrial task, and, from the data thus obtained, the endeavor to fix the proper time the task as a whole should take. *Motion study* is the study of the movements involved in a task with a view to eliminating such as are unnecessary and improving those that are necessary. It may be divided into *extensive motion study,* which is concerned with the arrangement of apparatus and the larger movements of the body involved in its use, and *intensive motion study,* which is concerned with the smaller movements of the hands and fingers. Time study and motion study are usually combined into one, called time and motion study.

In order to understand what may be expected from time and motion study, its origin and present development must be considered, and the exact aims that those engaged in it set before themselves; and also how far these aims are legitimate, and how far they can be attained by the present methods.

Taylor's System.—The object which Taylor set before himself was the standardization of labor, and, in order to arrive at the proper standard, he instituted a system of time study. His method was to divide work into its various elements and time them separately. The results were then summed, and a certain percentage added for unavoidable delays. Taylor's practice was to time first-class men who were induced to work as fast as possible by increased remuneration. As soon as the time study had been made, a workman was

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started on his new "task," which "required him to do between three and one-half and four times as much work in a day as had been done in the past on an average" (1).

The earnings of the men on the new system were, on an average, 60 per cent. greater than on the old system. The result was attained not so much by any improvement in the movements involved in doing the work as by fixing a certain standard time which had to be adhered to if the men were to earn the sum which they were obliged to earn in order to keep their places. Scientifically regulated rest pauses were also introduced, and these undoubtedly played an important part in the final result. Taylor advocated making the "task" as difficult as possible, so that only the best men could perform it. By this method he gradually eliminated all so-called second-class men.

Such a system may be commercially advantageous but it hardly goes to the root of the fundamental problems connected with the human element in industry. Much of Taylor's work is devoted to what he calls scientific management and a consideration of the best method of remuneration (2). The scope of the present memorandum does not extend to these aspects of Taylor's system; nevertheless, they form an essential part of his system, which rests more upon careful oversight and liberal payment than upon scientific principles connected with the human organism.

Considerable controversy has centered round Taylor's work. Some seem to regard all he did as almost beyond criticism. They point to his undoubted successes as sufficient indication of the essential soundness of his method, and regard all who criticize him as actuated by motives less worthy than those of Taylor. On the other hand, there are those who regard all that he did either with derision or direct hostility. They fasten their eyes on certain weak points in his system and refuse to consider those aspects which are of more lasting value.

To follow either of these extreme courses is unwise. When we think of Taylor's dealings with labor, either organized or unorganized, we must never cease to remember that he is dealing with labor conditions as they presented themselves in America, not with the conditions with which we are familiar in England. Certain points of his system may appear somewhat crude, but he was a pioneer in an unknown field of research, and we ought not to expect that his system could reach the standard of perfection, which those who come after him and who have the benefit of his experience may set themselves as the goal to be attained. Taylor's great and lasting contribution to the science of industry is the method which he adopted. He approached, in the spirit of scientific inquiry, problems which had been thought either not to exist or to be easily solved by common sense. He worked patiently for years to satisfy first himself, and then others, that by careful observation and accurate timing principles could be arrived at which governed the right employment of a worker's time and energy. Those who come after him and work upon the same problems, may criticize aspects of his system, and may disagree with certain of the ends which it has been made to serve, but nevertheless they owe him a great debt for indicating and developing a method, the possibilities of which are great.

Gilbreth's System.—Gilbreth set himself the same task as Taylor, namely, the standardizing of the human element

in industry; he, however, goes further than Taylor, for not only does he standardize the time for doing a task but he also standardizes the method. Taylor is mainly concerned with time study and rest pauses; Gilbreth is concerned with motion study as well (3).

Gilbreth's method is first to analyze an operation into its smallest constituent parts. These are then timed. With Taylor this would have been sufficient, for he would have taken the sum of these timings, plus the time allowed for unavoidable delays, and called that the standard time. Gilbreth, however, is not satisfied with this, but compares the different constituents of a given operation with the same constituents in a similar operation performed by other operatives. If the timings for different units of the operation vary in different workers, he selects the shortest timings from each operative, sees how the actual movements differ from those of other operatives who take longer to perform that unit of the task, and then sets a standard time composed of the sum of the shortest constituent factors in each operation, and a standard method of doing the work composed of the movements of those whose time is shortest. Thus, with two workers, whom we may call X and Y, he may find the timings of X for an operation consisting of four timeable units to be A, B, C, D, and the corresponding times of Y to be a, b, c, d. From these times he will select the shortest; let us suppose these to be A, b, C, d. He will examine the motions connected with each of these selected time units; A and C will be found among X's movements, b and d among Y's. These four movements coming from two different workers will then be combined into one series of movements which will be adopted as the standard method of doing the task, the standard time having already been arrived at by selecting the shortest time units from the two workers. This yields two parallel series which may be represented thus:

Shortest Time	Motion
A....	Motion as performed by X
b.....	" " " " Y
C....	" " " " X
d.....	" " " " Y

This method of procedure is interesting, and is a distinct advance on Taylor's method, which did not concern itself with the actual movements employed, provided that the task was performed in the standard time, the proper rest pauses were adhered to, and the final result was satisfactory to the overseer. Gilbreth sees that the method of doing work plays equally as important a part in the performance of any work as the time taken to do it. Gilbreth's methods would, however, have been more instructive if he had not introduced the disturbing factor that Taylor always introduced, namely, increased pay and various other methods of "encouraging the workers to put forth greater effort."

Further, it seems highly doubtful whether various movements, taken from different groups of movements, merely on account of their taking a shorter time to perform than similar movements in other groups, can be combined into an independent group which would yield results as satisfactory as either of the original groups. The method of performing a given task is similar to the so-called "style" of a cricketer or golfer, who certainly would not build his style on a composite mixture of other people's styles. It is far more satisfactory to study one style and become perfect in that, than to study many styles which may yield only the

result of being imperfect in all. We cannot, however, pass final judgment on the method because it has never been tried by itself unaccompanied by special inducements to increased effort; but the results which Gilbreth has obtained do not prove that there is *a* best method of doing any operation. There are, undoubtedly, good methods and bad methods; the good may be encouraged and the bad discouraged, but the actual method finally adopted by the worker must be the one which he finds most convenient, that is, the one best suited to his physical and psychological make-up.

Criticism of Taylor's and Gilbreth's Methods.—Both Taylor and Gilbreth set before themselves the definite task of standardizing the human element in industry. They wanted to make industry more efficient by reducing the cost of production. Some people, when they attempt to reduce the cost of production, think primarily of lowering the wages paid to labor, but Gilbreth and Taylor made no such mistake. They both realized that to reduce the cost of production by such a method is, in ordinary circumstances, short-sighted and fails in its real object.

They approached the subject from a more scientific standpoint, and attempted not to reduce the wages of labor but to increase them, provided that such an increase is accompanied by an increase in output. They did not leave it at this, but, by their methods of time and motion study, they sought to ascertain how and in what degree real improvement was possible.

The method adopted by them was one that paid considerable attention to the welfare of the worker. Taylor was careful to see that sufficient rest was introduced into the day's work, and Gilbreth has gone further and paid attention to such things as comfortable seating and bench accommodation. Nevertheless, in spite of these considerations their systems have met with a great deal of opposition on the part of labor, a fact that gave Taylor great concern. Hoxie (4) in his report on "Scientific Management and Labor" and also the committee appointed by the House of Representatives in its report show clearly that in factories working under the Taylor system there is evidence that the workers think they are required to work at a speed which, in the long run, is detrimental to their health. Still, the evidence taken from workers by the committee appointed by the House of Representatives is to the effect that no real objection is felt to those parts of the Taylor system which deal with systemization and standardization, but that strong objection is felt to the methods of stimulation.

This objection to methods of stimulation seems to go to the root of the whole matter, both from the workers' point of view and also from the point of view of those whose approach to the question is one purely of scientific interest. The latter realize that there is a physiological and psychological background to the whole of human effort, and they want to discover whether the methods adopted in time and motion study really go to the root of the matter and indicate more economical ways of utilizing human effort. Great improvements in efficiency have been effected by the introduction of new ways of performing certain industrial operations, but whenever these improvements have taken place, there have been two changes, one in method, and one in the system of remuneration, and we are at least entitled to inquire which is the predominating factor.

Workers can certainly be spurred to

greater effort by methods of remuneration calculated to penalize the slow workers and reward the quick worker, but such results are of more interest to those who are studying methods of remuneration than to those whose only concern is the fatigue of the worker. Taylor was not studying either; he was primarily concerned with the problem of output, and set himself the task of increasing the production of the various firms in which he worked. He is quite frank on the matter. He says (1, p. 143): "All employees should bear in mind that each shop exists, first, last and all the time, for the purpose of paying dividends to its owners." This is not the place to offer any criticism of such a statement, but anyone holding that view and, at the same time, devoting himself to the problem of production, will clearly use different methods from those employed by persons concerned primarily with the fatigue of the worker.

The above criticism must not be taken to imply an objection to any particular system of payment, or to change in the method of payment; but such systems or changes should be unaccompanied by any change of method if they are to provide data bearing on the problem of increased effort. Similarly, any change of method which is to yield reliable data bearing on the same problem must be unaccompanied by any change in the system of payment.

Both Gilbreth and Taylor make their systems depend primarily upon speed. Taylor always timed the quickest worker, and the standard which he set for any task was based on the results thus obtained. He certainly added a percentage of time to cover unavoidable delays, and also instituted regular rest pauses, but what he always sought was speed. In no less a degree does Gilbreth make speed his ideal. He regards the quickest movement as the best, and even goes so far as to say that in teaching a new movement speed must be insisted on from the very first. He regards speed as more important than accuracy of movement or quality of work. His reason for adopting this point of view is that the path a movement follows is different when the movement is done quickly from when it is done slowly. This is, in the main, true, but even so, whether speed should be insisted on from the beginning may be regarded as doubtful.

Further, we may doubt whether speed is the best criterion for judging a movement. From Gilbreth's point of view the quickest movement is the best, and so long as speed is the object to be attained this must necessarily be so. Nevertheless, the quickest movement may not be the easiest and the best for the worker to accustom himself to. It may make too great a strain on the nervous system to be advantageously employed by all workers. As has already been pointed out, these quick movements are selected from various workers; possibly they may in some way be closely connected with the physical and mental make-up of the worker in question, and their transplantation as isolated motions into the movement system of other workers may be unwise.

Standardization.—The standardization of the human element in industry is the object which both Taylor and Gilbreth put before them. The former sought mainly to standardize the time to be taken in performing a task; the latter went further and standardized the method also. Standardization of all human effort would, without doubt, be a great convenience for employers, especially if that standard was a con-

siderably higher one than they were wont to expect, but in setting this standard the greatest caution must be exercised.

In the first place, we must consider whether, from the workers' point of view, the fixing of a standard that they are required to reach is advisable. It may become a constant source of irritation to them to feel that they must reach a certain standard every hour, or every day, as the case may be. On certain days when they are suffering from slight indisposition not sufficient to keep them away from work, they may wisely do less work than they might be able to do if they exerted all their effort. On other days when they are feeling extremely energetic, they may be able to surpass the standard, and if left to their own devices they might do so. The thought that they were only expected to keep up to the standard might debar them from putting forth all their energy, lest the standard should again be raised and made more difficult to attain on days when they were not feeling particularly energetic.

Beside these personal factors that might affect the workers' ability to reach the standard, there are those influences which all workers are affected by, though in varying degrees. Among these we must count temperature and weather conditions, and the physical factors that periodically affect women.

With regard to the standardizing of motions, it is doubtful if a set of movements, however good, can necessarily be regarded as the best for every person concerned. Personal differences must be allowed for and the possibility admitted of the worker's discovering a method better suited to his requirements than the prescribed one. In the majority of cases the standard method may prove the best, but in no case should it be forced upon a worker. Every worker should be taught the standard method and then allowed to follow his own devices, provided the results are satisfactory.

New Point of View in Undertaking Time and Motion Study.—If time and motion study is to be systematically adopted in industry, then those who are engaged in it must endeavor to avoid certain errors that have been made in some of the applications to which it has been put. The object for which the work is undertaken must be different, and the type of men employed in the study must likewise be different.

The literature dealing with time and motion study shows that it has been left far too much to those whose main object is the increase of output in some particular industrial concern. Hence the tendency at times has been to overlook the fundamental principles lying at the base of the study, and to concentrate attention on the immediate results to be obtained in the particular factory in which the person carrying on the study is interested. If, however, real advance is to be made along the lines which Taylor and Gilbreth have indicated, the matter must be treated from a broader viewpoint. Improvements in particular factories are not sufficient, however useful they may be, but an endeavor must be made to discover the general principles that govern human effort in industry. So long as the matter is left entirely in the hands of those whose main object is increased production there will be a tendency for the worker to feel, rightly or wrongly, that he is in some way being exploited. If, on the other hand, he realizes that the study is being carried on by those whose only interest is lessened fatigue, he will learn to regard the matter in an entirely different light.

Certain preliminary investigations have to be made before motion study proper can be undertaken, and the first of these is the investigation of unproductive labor. In almost all industrial operations that have not been regulated according to a well-thought-out plan, a considerable amount of time is wasted by the skilled worker in purely unproductive labor. It may take many forms. The skilled worker may be required to fetch the materials on which he is to work, or to remove them when he has finished. He may be required to prepare the tools which he is to use, or to perform some operation subsidiary to the main one. Such unproductive labor may not, in itself, be a bad thing, since it may provide a rest for muscles that are continually being used in the main operation; in so far as this is the case and such rest cannot be conveniently provided otherwise, it is undesirable to have this work done by a less skilled worker. Whether such interruptions in the work are advantageous or not will depend largely on the nature of the work and the amount of energy put forth in performing the tasks that act as interruptions to the main occupation, and this can only be determined by actual experiment. Besides the actual labor that a worker may be required to do on jobs subsidiary to his main purpose, he may be kept waiting from time to time on account of the method of supply. Whether this enforced rest is beneficial or not is also a matter for experiment, and must be governed by such factors as regularity and duration of the pauses.

Motion Study Proper.—Motion study, according to the definition already given, seeks to eliminate unnecessary movements and to improve necessary ones. This may be taken as a general definition, which will include various methods of improvement. What is meant by improvement must be understood before judgment is passed on the desirability of motion study.

If speed is the object sought, the value of any movement must be judged by its speed. There may, however, be another standard by which movements can be judged, namely, that of the ease with which the worker can perform the movement in question. Those who take this view will dismiss the speed factor entirely from their minds. They will endeavor only to devise some method of doing the task in question, which will be more in accord with physiological and psychological laws, and which will utilize the natural aptitudes of the worker in a more efficient way. Those working on this principle will not seek to discover how quickly a worker can perform a task, but will endeavor to arrange that the task may be done in such a way as to interfere in the least possible degree with the worker's rhythm. The effort of the worker, and not the task, will become the center of attention.

If this principle is adopted, the question arises as to how we are to know whether improvement has taken place by the introduction of a new set of movements. The method usually adopted has been to accompany the introduction of a new system of movements with a carefully devised method of payment calculated to stimulate increased effort and to penalize any falling away from the standard that has been set. Under this system increased output is regarded as an indication that the system of movements introduced causes less fatigue to the worker than the movements that were superseded. This may or may not be the case.

At present there is no reliable measure of fatigue that can be applied un-

der factory conditions, and until such a measure is discovered we must content ourselves by judging the success of a new system of movements in the following way.

The essential features of the new method should be, first, that it is more in accordance with physiological and psychological laws, so that the body and mind are used in the most economic way by avoiding all possible strain. Secondly, the new method should meet with the approval of workers who have given it a fair trial, and should have the result of making them feel less tired and more satisfied with their work. If these requirements are fulfilled, then the result may be regarded as satisfactory.

An increased output may or may not result. This will depend on how much improvement has been effected. If it is sufficiently large to allow the body to do more work, then greater output, if the same hours are worked, will be the natural result. If shorter hours of work are adopted, then the result may take the form of doing the same amount of work that was previously done in longer hours. If the improvement is not so great, the only result will be that the worker is less tired after the day's work than he was before. The inability to make so large an improvement as to affect output under the conditions laid down, must in no way be attributed to the experimenter or the worker. The nature of the work may be such that an appreciable improvement affecting output is impossible, either because the work is so fatiguing that the body soon reaches its limit under any system, or because the sphere in which motion study can be applied is too small.

In all cases that have come to the writer's notice, where the principle suggested has been the basis of a new set of movements, increase of output and increase of earnings have actually taken place, though in no case was any effort made to get the workers to increase their output.

Rhythm.—In most industrial processes there is a set of movements which is strictly necessary for the performance of the work; there is another set which is made necessary by the bad arrangement of materials or the inexperience of the workers; and there is a third which can only be accounted for by assuming that it represents the rhythm to which the worker has become used. The first set of movements cannot be done away with as long as the work remains essentially the same, but it can be altered by intensive motion study. The second set of movements can be entirely eliminated or altered by what has been described as extensive motion study, but the third set is the most difficult to deal with, and also the most necessary to deal with if the fatigue of the worker is to be the real concern of the investigator.

These three sets of movements are not really separate, but together form a group of movements which has become traditional in the performance of any industrial process. Some difficulty may be experienced in determining to which set any particular movement belongs, but if the matter is to be properly taken in hand the attempt has, at least, to be made. When unnecessary movements have been eliminated by extensive motion study and necessary movements improved by intensive motion study, the experimenter must consider how far the remaining movements, due to the sense of rhythm in the worker, are necessary, and how far they can be modified and improved.

The ideal is to make the necessary

movements so rhythmic and graceful that no extra movements are needed as an appeal to the worker's sense of rhythm. Generally, workers who have had long experience at a particular type of work develop a great number of unnecessary rhythmic movements which may be difficult to give up. Probably attempts should seldom, if ever, be made to get workers who have become accustomed for many years to one set of movements to relinquish them in favor of another set. The movements have become semi-automatic and great discomfort is caused in any attempt to break a formed habit. Beginners are different. If they are taught a graceful and rhythmic set of movements from the beginning they will form habits of work which, when once established, will be difficult to give up; but such habits, if based on scientific time and motion study, will render work so much more easy than under the old system that presumably there will be no necessity for them to be given up.

If the improved set of motions is of really rhythmic character, there will be little tendency to superimpose other rhythmic motions on it. A superimposed rhythmic movement is one which is not actually necessary to the performance of the task, but which is introduced by the worker, possibly in order to synchronize with some physiological rhythm whether of muscular contraction, heart beat or breathing. But whatever their cause, these movements should not, unless they are having markedly bad results, be objected to.

The sense of rhythm should form the basis of any scientific system of movements, but naturally no rules can be laid down with regard to it. The object which an experimenter should place before him is to devise a set of movements that will do the work properly and, at the same time, be able to set up rhythmic motor habits in the worker. One movement should follow on naturally from the one preceding it, and the terminal phase of the preceding movement should naturally suggest the initial phase of the next.

A large field of research lies open along these lines. At present, little is known about rhythm in industrial processes, although it must play a large part. However much a method of doing work may be improved, there are always variations in the effect which it has on different individuals. The average of output may be raised, but the variation about that average remains the same. This variation may be due to many causes. Rhythm and motor control probably play a large part in it, and it may also be in some way affected by varying types of fatigability. Research into these problems would be of great service to those who are interested in the subject of time and motion study.

Part II: Examples of Motion Study

An Experiment in Sweet Dipping.—The process of "dipping" consists of putting a "center" (an almond, walnut, Brazil nut, or caramel) in a basin of melted sugar with the left hand, and covering it with the sugar by working it with a fork held in the right hand, and then placing the finished sweet on a tray. The path usually followed by the worker's hand when dipping was found to be such as Figure 1 may illustrate. (See page 165.)

This diagram does not, of course, represent the exact line followed. No human movement would ever be so exact, besides which no account has been taken of certain small movements made necessary in order that the sweet may

be of the proper size. The exact path followed by this movement may be seen in Figure 2, the lettering in which corresponds to the lettering in Figure 1. The stroke AB is not given in Figure 2. Its commencement can be detected at about the same place as is afterwards covered by C. In Figure 3 its commencement can be more easily seen.

The right hand holding the fork goes from A to B and takes up a portion of the thick liquid and pulls it over the "center" at X. When the hand reaches C it goes forward toward the left side of the bowl with the end of the fork under the center. The center is then picked up at D and deposited in the tray. This would appear to be the best way of doing the operation, because the hand is always travelling in approximately straight lines. The defect of this method is that the hand stops at B and goes in the opposite direction and also at C and goes again in the opposite direction. The necessity of having to stop the arm twice and change the direction causes unnecessary strain to the arm muscles.

After some personal experience on the part of the experimenter in the process of dipping, he decided to recommend a method in which the hand moved in curves instead of in straight lines. The new method is diagrammatically represented in Figure 4.

The hand, after depositing the finished sweet, leaves A and reaches B on the surface of the boiled sugar in the middle of an inward and downward curve with the hand in its strongest position for doing work. The momentum gained by the movement A—B is thus utilized for the most tiring part of the work instead of being entirely wasted by checking the movement in order to change its direction, as in the old method. This curve sweeps the sugar over the center and, going under it in the second part of the curve, comes up again at C. The sweet is then deposited on a tray. A circle in the same direction is made there, also, in order to finish off the sweet. In this method the hand is never brought to a sudden standstill but continues in an even circular movement, all change of direction being effected by curves and not by stopping the hand. Moreover, it has the advantage that the fork strikes the boiled sugar (the part of the process offering the greatest resistance to the hand) with a downward and inward stroke and with the full momentum gained by travelling from A to B. In the old system this part of the process was done by a short backward movement just after the hand had stopped and changed its direction. The diagram of this motion should be compared with Figure 3, in which the curve B—C can be clearly seen. Figures 1 and 4 represent the movement as seen by the worker; Figures 2 and 3 represent the movement as done by the worker and seen by the observer standing in front of the worker.

The best workers in the department were then examined to see if any of them worked in the method suggested. The three whose output was greatest were found, at times, to adopt a method similar to, though not quite identical with, the one suggested. Workers who had been accustomed for years to another method of work could not be induced to adopt the new method. An endeavor was therefore made to get the younger members of the department to adopt it, and for this purpose a class was instituted. The result, after a short period of training, was an average increase of 27.1 per cent., but even this increase did not fully represent the benefits to be gained by the new method.

The instructress who had charge of this class was not a very proficient teacher, and the young girls, seeing older girls around them working in a different way and, of course, turning out more than the younger girls were able to, showed a tendency to drop the method which they had been taught, and to adopt the one which they found going on all around them, and, apparently, producing better results.

For this reason attention was concentrated on a new room that was to be started. A more proficient instructress was found, a new-sized table and trays were employed, and arrangements were made whereby the workers were enabled either to sit or stand while at work. This new room was lighter and better ventilated than the old one had been. After three months' work in the new room the workers were, on an average, producing 88 per cent. more than workers of the same standing who were using the old method in the original room. This increase meant that girls of 14 and 15 years were earning a sum equivalent to that earned by girls of 18 in the old room, showing that the correspondence between age and output in the old room was not entirely due to the superior strength of the older girls, but that difficulty in forming an easy motor habit at least had something to do with it. The new system of movements was far more natural than the old one and, therefore, presumably easier to learn.

An Experiment in Bottling Sweets.—The process of putting sweets into small glass jars is one that entails a considerable number of operations. The experimenter noticed that the workers tended to do nearly all the work with the same hand. They would pick up the jar from the right hand side with the right hand, work on it with both hands, and put it down on the left hand side with the right hand. Or they might pick up with the left hand from the right side and put down on the left side with the left hand, and every other possible combination of right and left hand was to be found. He thought that if the work could be more equitably apportioned between the two hands, and some system devised where both hands worked simultaneously instead of one working while the other rested, a more satisfactory way of doing the work might be found.

A distinction must here be made between ambidexterity and bimanufiability. By the former is meant the power of being able to do an operation equally well with either hand; by the latter, the power of doing one thing with the one hand while doing something else with the other. Persons who shave themselves with either hand are ambidexterous; persons who can put down an object with one hand while taking up another object with the other are bimanuficient. Ambidexterity is not brought into play in the process of bottling here described, but bimanufiability is.

A system of movement was devised which depended on the latter quality being utilized, and elaborate diagrams were made of the movements for each process, but the workers could not be made to understand what was required of them. A method of doing the work was, therefore, devised by which the whole process, instead of being done by one worker, was done by a team of workers, each worker doing one particular operation. To facilitate matters, a moving belt was placed on the bench along which the jars traveled to be thrown off close to the worker who was to do the next process.

In order to avoid having any worker

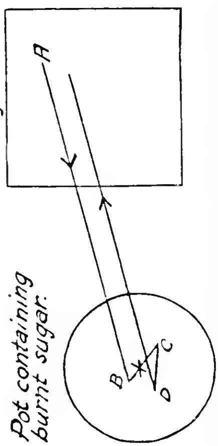

FIG. 1. Diagram of old method of sweet dipping.

FIG. 2. Usual method of sweet dipping.

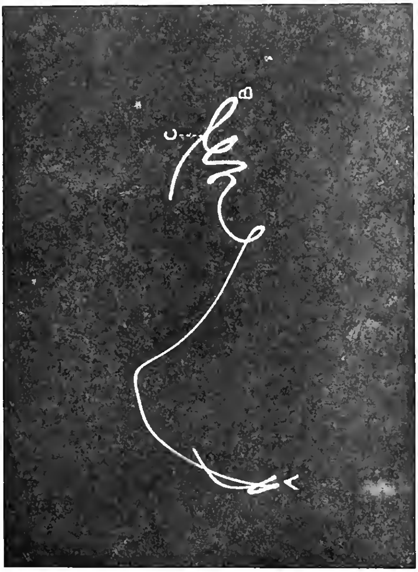

FIG. 3.—New method of sweet dipping.

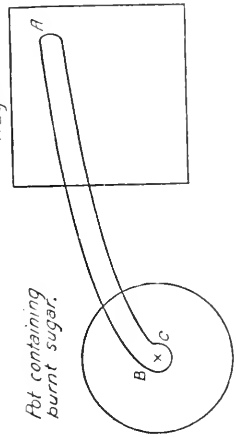

FIG. 4. Diagram of new method of sweet dipping.

perform one process for too long a time, no girl was required to screw lids on to the jars for more than half an hour. This operation was the most tiring in the process. The relief given to the "screwer on" provided an opportunity for a change for each worker every half hour, which was better than any arbitrary arrangement that it might have been necessary to make, if all the processes had been of equal difficulty.

The new system, after working for some time, resulted in the workers' average output and earnings being about 50 per cent. greater than when the previous system was in vogue. Further than that, so much floor space was saved by the new method that the room will accommodate 90 per cent. more workers than was previously possible.

The interesting feature of this experiment is that the method of work adopted provides that the jar to be worked upon shall always arrive at the right hand side to be picked up by the right hand, and that the jar that is finished is always put down on the left hand side; this process is facilitated by the belt. The result is that without any instruction the workers have learned to pick up one jar while they put down another, in fact have learned in this respect to become bimanuficient.

An Experiment in Covering Chocolates.—In covering chocolates, the worker drops the center into the chocolate with the left hand and covers it with a fork held in the right hand.

Almost every worker in the chocolate dipping department was found to possess a different method of work. Some were able to perform the operation with a comparatively small number of movements, and others employed a greater number of movements. The workers differed in the size of the movements which they employed, some making extended movements though few in number, and others making the same number of movements though less extended in nature. This can be illustrated by reference to Figures 5 and 6.

The investigator hoped that he would be able to reduce the number of movements employed by getting the workers to adopt the rhythmic curved movement which was employed in sugar dipping, but he realized that no definite rule could be laid down as to the exact number of movements necessary on account of the technical difficulties connected with the thickness and temperature of the chocolate. He therefore decided to suggest a method and to leave it to each worker to determine how many movements she would take to do the work.

The workers found the new method so easy that in a few months their piece rate earnings were equal to the earnings of girls of several years' standing. When they had reached that standard they were moved into the room with the other workers. Many of the older workers became most interested in the new method and began to pay attention to the number of movements employed. The forewoman was of the opinion that the new method had had a most beneficial effect upon the whole department, and she was sure that the dippers as a whole were employing fewer movements.

An Experiment in Chocolate Packing.—There are various ways of arranging for a supply of chocolates to be packed, but the most usual is either to arrange the chocolates on trays, one above the other, immediately in front of the worker, or to have them in boxes spread out before the worker in two horizontal planes. The system of pack-

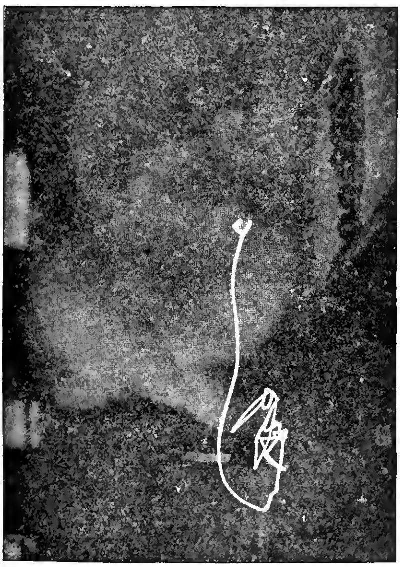

FIG. 5.—Best worker in chocolate packing department.

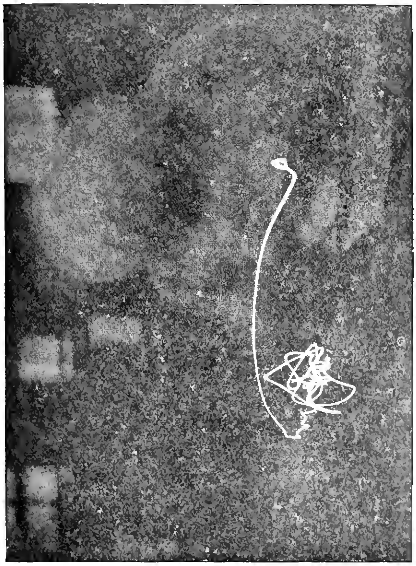

FIG. 6.—Worker of many years' experience making many unnecessary movements.

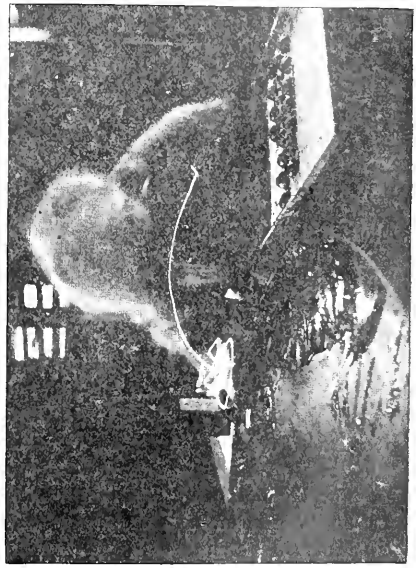

FIG. 7.—One of the pupils after six months' experience.

ing in vogue in the particular factory in which the experiment was carried out was of the latter type.

The only way to insure easy rhythmic movement on the part of the worker was to design patterns which made it possible and which at the same time were attractive to the eye. This was done, with the result that the new patterns necessitated that chocolates be taken from the boxes in something like the following order:

Bottom Layer	Top Layer
1, 2, 3, 4,	11, 12, 1, 2,
5, 5, 5, 5,	3, 3, 3, 3,
6, 7, 8, 9,	4, 5, 6, 7,
10, 10, 10, 10,	8, 8, 8, 8, etc.

This is only an example, and an infinite number of patterns are possible which still allow the worker to move in an ordered way. The worker's hand still has to move from the center of the bench, where the box which she is packing is situated, to the circumference where the boxes from which she is taking chocolates are situated; but instead of having to make a separate decision each time a chocolate is required as to which box to find it in, her movements can now be made in a semi-automatic fashion, simple movement associations being formed which directly correspond with the visual association of the required pattern.

A new bench was designed which enabled the worker to sit while at work, and the boxes from which she was packing were arranged in a semi-circle instead of in a straight line in front of her. The sides of the semi-circle worked on hinges and could thus be easily adjusted by the worker to the position in which she found it most comfortable to work. The new method of packing resulted in an increased output of 38 per cent.

In all these experiments no stimulus of any kind was given to the workers to increase their output. The principle in each case was to devise what was believed to be an easier way of doing the work and then to leave the matter in the workers' hands.

Summary

Time and motion study is of great industrial importance. It was introduced by Taylor and followed up by Gilbreth with the direct object of increasing output; the former timed the quickest workers, while the latter, by timing units of movements, determined a shortest possible time; both these pioneers urged on workers to attain the pace fixed. Workers object that both these methods which aim only at speed result in unhealthy drive.

A new point of view is now proposed which concentrates attention on ease of movement and not on speed of production, on the effort of the work and not on the task. The object is, by making necessary movements rhythmic and graceful, and by eliminating unnecessary movements, to minimize fatigue and produce pleasure in work. Increased output is not the objective, and may or may not result. It is significant, however, that in every case that has come under the writer's notice, where this new principle has been employed increase of output has in fact resulted.

Practical applications of this new point of view at a process of sweet dipping resulted in an increase of output of 88 per cent.; at bottling sweets, in an increase of 50 per cent.; at covering chocolates, in greatly shortening the time required for acquiring proficiency; and at chocolate packing, in an increase of 38 per cent. No stimulus was used in these experiments to induce the operatives to work faster.

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TUBERCULOSIS AS IT AFFECTS THE INDUSTRIAL WORKER*

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THE relationship between tuberculosis and the industrial worker is so complicated and involved, and presents so many phases of interest to the industrial physician, that it would be impossible to do more than refer briefly to certain of the more important phases of the subject. There is no disease which is so important from the standpoint of the industrial physician, as it appears in so many varied forms and may so completely disable the workman, frequently after a prolonged period of partial disability with the loss of a considerable amount of time and efficiency. The onset is usually so insidious that the disease becomes well advanced before its true nature is recognized.

During recent years great stress has been laid upon the importance of childhood infection with tuberculosis, and the frequency of adult infection has been questioned, but the studies upon which this view is based are of such a character that it would seem inadvisable to neglect any of the precautions which have hitherto been employed to prevent the dissemination of the tubercle bacilli among adults. In industry the detection of the disease is of the utmost importance to the employer, the employee affected, and his fellow-workers.

The relationship between tuberculosis and industry constitutes one of the most important problems bearing upon the prevention of this disease, the solution of which unfortunately presents many difficulties. It is almost impossible to determine in any individual case how important a part has been played by occupation, and to what extent home environment and mode of living have been responsible for the development of the disease. A weak point in most of the studies of tuberculosis in industrial bodies lies in the fact that the home conditions of the workers have been ignored. The disease is extremely prevalent among the poor industrial workers—that large group which is usually exposed to crowded, poor living conditions, poor food, dissipation, and similar factors which we know may be responsible for the development of the disease and may favor its spread.

There can be no question that working under unfavorable conditions results in an increase of the disease and that improvement of the general hygienic conditions of the plant is followed by a reduction in its frequency. Industry, then, bears the same relation to tuberculosis that the home environment bears to it; it is just as essential that the working conditions should be favorable as that the home conditions should be. In studying tuberculosis in any given industry, one must not only consider the special trade processes involved, but also the general conditions as to light, ventilation, etc. There are certain trade processes and occupations, especially those in which irritative types of inorganic dust constitute a hazard, which have such a high mortality rate from

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tuberculosis that they have always been regarded as definite predisposing factors.

The effects of industry have been summarized by Dr. Hayhurst (1) as follows: (1) deaths from industrial diseases are rare; (2) specific occupational diseases, such as, for instance, those due to poisons, are fairly common; (3) non-specific occupational diseases, represented by chronic infections and degenerative processes, are very common; while (4) health complaints in which the occupation enters as a chief factor are almost universal. He further states, "It is startling when we realize that such an innocent occupation as that of the telephone girl is associated with a tuberculosis rate of 43 per cent. of all deaths among this class of workers, and that the stenographer suffers a rate of 39 per cent. from the same disease."

Another phase of the tuberculosis problem of considerable practical importance, especially from the standpoint of the industrial plant, is the relationship between pulmonary tuberculosis and trauma. Evidence regarding a sufficient number of cases has been established in which tuberculosis has followed traumatism—in individuals known to have been free of all evidence of the disease prior to the injury—to warrant one in accepting trauma as a possible cause for the development of the disease. The physical examination of applicants for employment and the frequent re-examination of employees are the only means of protection which a plant possesses against being unjustly held responsible for tuberculosis in persons who, when injured, claim that the traumatism is responsible for the disease.

When one studies the frequency with which tuberculosis is encountered in industrial bodies, one encounters difficulty in securing data so formulated that a definite comparison of one plant with another can be made. Some statistics refer to males, some to females, and others to both sexes. In some instances where both sexes are included, the proportion of males and females, with the corresponding rates, is not given. Often no mention whatever is made of the sex of the workers. Similarly, no distinction is made between white and colored workers. Very few statistics give the average age of the workers and practically none are arranged according to age group. Rarely is mention made of the exact occupation of the individuals affected. Occasionally the number of examinations is given, but generally no reference is made to the total number of workers employed, the reason for the examination, the method of examination, or the grounds upon which the diagnosis was based, etc. Some physicians employ the term "serious lung defect," and fail to state the nature of the defect; some include suspected tuberculosis and definite tuberculosis under one heading; others include them under separate headings. It is not surprising, in view of this lack of uniformity, that the tuberculosis incidence rates in Table 1, which I have collected from various sources, show such an exceedingly wide variation, running all the way from 0.02 per cent. to 6 per cent. The definite tuberculosis cases in which the complete figures are given show an average of 1.494 per cent.

The great variation between the findings of the different authors in various industries cannot be accepted as being indicative of the influence of the industry itself upon the prevalence of the disease, as there are too many other factors which must also be taken into consideration—such as age, sex, color, methods employed, and the individual opinion of the examining physician as

to what physical signs and symptoms are to be considered as indicating the presence of the disease, and as to what care was exercised in making the examination. This personal equation of the examining physician is probably one of the most important factors involved. While the incidence rates given in this table are by no means constant, they are sufficient to indicate that the disease is so generally prevalent as to warrant our employing every possible means to prevent it.

Viewing the problem from a slightly different angle, it is interesting to see how many days per employee are lost annually through tuberculosis. In his excellent article on industrial absenteeism, Dr. Quinby (18) states that in the industrial plant of which he is medical director pulmonary tuberculosis was responsible for the loss of 0.246 days per employee during the year 1920. Excluding acute infections of the upper respiratory tract, tuberculosis had the second highest rate of any disease or group of diseases. Diseases of the stomach had a higher rate (0.297), and rheumatism had a slightly lower rate (0.235). This gives one a clear appreciation of the importance of tuberculosis from the industrial standpoint.

Fortunately, we have at our command a method of detecting tuberculosis among industrial workers, namely, by means of entrance examinations combined with periodic health examinations. If carefully conducted, this procedure will undoubtedly help materially to reduce the number of cases within a relatively short period of time, provided the hygienic condition of the plant is good. It must be borne in mind, however, that by examinations I mean complete examinations for all defects and diseases, for it is neither practical, economical, nor expedient to conduct an investigation of this kind for the detection of one disease alone. As a matter of fact, every defect or disease detected and corrected, and every step taken to improve the health and well-being of the individual is a step toward the prevention of tuberculosis.

The entrance examination has been fairly generally employed and is in operation in a large number of plants because it is a procedure which more readily appeals to the employer, promising a definite, tangible return by eliminating the seriously disabled and diseased workmen, and also serving as a control on the type of work which may be performed by workmen with a moderate disability, preventing them from engaging in an occupation which would aggravate their defects. The results to be obtained by periodic health examinations are not so obvious to the employer, and consequently it is difficult to convince him of the value of a health program in which both entrance examinations and periodic health examinations are included.

While the entrance examination may serve to keep out of the plant seriously diseased individuals and may help to place men at work for which they are physically fitted, it is concerned only with the new employee — usually the least valuable to the plant—and does not include the valuable workmen who have been in the employ of the plant for some time. Any attempt to keep these older employees under observation by examining them when sick is of relatively little value to the plant; they should be examined periodically before they become actually ill, when the first manifestations are present, and at a time when a change of occupation, perhaps, or treatment while at work may be sufficient to prevent illness.

Tuberculosis is a disease which, like

TABLE 1.—TUBERCULOSIS RATES IN INDUSTRIAL STUDIES COLLECTED FROM VARIOUS SOURCES

Author	Industry	Title of Defect	No. of Cases	Incidence Rate %	No. Examined	Applicants	Employees	Male	Female
Auel (2)	electric mfg. co.	serious lung defect	17	0.09	18,390		x	x	
	" " "	" " "	44	0.14	29,805		x	x	
	" " "	" " "	90	0.50	17,858		x	x	
	" " "	" " "	2	0.05	3,628		x		x
	" " "	" " "	4	0.07	5,583		x		x
	" " "	" " "	1	0.03	2,944		x		x
Buzby (3)	leather works and cannery	unquestionable tuberculosis	—	0.80	1,500	x	x	x	x
Lowman (4)	steel company	lung disease	35	0.28	12,302	x	x	x	
	" "	" "	59	2.42	2,430	x	x	x	
Kellogg (5)	department store	active tuberculosis	19	3.80	500				
		inactive tuberculosis	8	1.60	(2,000 employees; 85% females)		x	x	x
	" "	active tuberculosis	6	3.00					
		inactive tuberculosis	2	1.00	200	x		x	x
Kellogg (6)	" "	tuberculosis	42	3.47	1,210		x	x	x
Clark (7)	grinding company	lung rejections	5	0.19	2,618	x		x	
Cutler (8)	" "	pulmonary tuberculosis	10	0.50	2,000	x		x	
Scheffel (9)	not stated; medium but hazardous	tuberculosis	1	0.33	300	x		x	
Britton (10)	International Harvester Co.	"	—	0.88	about 20,000		x	x	x
			—	0.54	" "		x	x	x
Schereschewsky (11)	garment workers	pulmonary tuberculosis	65	3.11 } 2.49	2,086		x	x	
	garment workers	the same	9	0.9	1,000		x		x
Price (12)	bakers	" "	—	2.40	800				
	tailors	" "	—	1.60	800				
	tobacco workers	" "	—	1.30	600				
	furriers	" "	—	6.00	83				
Fisk (13)	insurance policy holders	possible tuberculosis of lungs	—	1.40	——		x	x	x
	commercial employees	the same	—	0.90	——		x	x	x
Mock (14)	clerks, 35% light skilled, 20% heavy mfg. and laboring, 45%	active tuberculosis	—	1.70	112,000		x	58%	42%
	miscellaneous, reports of ten surgeons	" "	—	1.40	——		x		
	steelworkers—U.S.P.H.S.	" "	—	0.92	936		x		
Robinson and Wilson (15)	miscellaneous	pulmonary tuberculosis	—	1.07 } 1.10	14,049		x	x	
				1.89	5,883		x		x
Craig	policemen and firemen	the same	103	1.80	5,706		x	x	
War Department (16)	drafted men	pulmonary and suspected tuberculosis	—	2.202	——			x	
	drafted men in Pennsylvania	the same	—	1.947	——			x	
Doty (17)	telegraph co.	tuberculosis	36	0.49	7,201	x		68%	32%

many others, usually develops insidiously, the patient frequently not considering himself ill until the disease is well developed or even advanced. This fact was strikingly illustrated in the examination of the policemen and firemen of the city of Philadelphia, recently conducted by the Phipps Institute of the University of Pennsylvania, in which nearly two-thirds (64 per cent.) of the cases of tuberculosis discovered had previously been entirely unsuspected, even by the affected individuals themselves.

In order to prevent the infection of other workmen and to secure a retention of the working capacity of the individual affected with tuberculosis, with the loss of only a relatively short period of time, the disease must be discovered early. There is no method for this early detection of disease which is at all comparable with periodic health examinations.

For the foregoing reasons I would like to make a special appeal for the installation of this method of study in every industrial establishment. While serious objection will, no doubt, be raised to such an elaborate and time consuming procedure, I believe that the difficulties are not insuperable and that the results obtained would more than compensate for the cost involved. It is impossible to estimate how great would be the influence upon the public health of a widespread employment of periodic examinations. A recent study of periodic health examinations by one of the large insurance companies has clearly demonstrated their economic value to such an organization, and I can see no reason why they would not be of equal financial value to an industrial plant. There can be no question that, from the standpoint of tuberculosis at least, the general employment of periodic physical examinations would constitute one of the most effective measures that could be devised for the advancement of preventive medicine.

To be of value it is essential that the examinations be made with thoroughness, care, and precision; otherwise the early cases of tuberculosis will be overlooked. There is no disease which varies more in its clinical manifestations than does tuberculosis; in some cases the general symptoms predominate, and in others the pulmonary signs are most marked. The latter type of case is more easily recognized by the examining physician than the former, which is frequently confused with some other disease. While the early recognition of the disease is not always easy, in the majority of cases a careful examination will reveal its presence. It is a mistake to view the early diagnosis of pulmonary tuberculosis as a very difficult procedure requiring expert training, employment of the roentgen rays and similar costly methods. More early cases pass unrecognized, through carelessness or neglect to examine, than are undetected on account of lack of training. There are, to be sure, a certain number of cases which tax one's diagnostic ability very severely, but they constitute only a relatively small proportion of the total number.

The cases which present the most difficulty are those in which there are symptoms or general signs suggesting the presence of tuberculosis, but in which the physical signs in the chest are indefinite or obscure; or, on the other hand, those in which there is definite evidence of pulmonary disease, suggesting tuberculosis, in which the sputum remains negative for tubercle bacilli. In both of these types of cases it may be found necessary for the in-

dustrial physician to seek the assistance of some one who has had considerable experience in diseases of the chest and who has access to laboratory facilities which will aid him in establishing a diagnosis.

The method to be employed in carrying out entrance examinations is so well known that it is unnecessary to refer to it at this time. The periodic health examinations constitute more of a problem, the method of procedure varying with the size of the plant, the number of workmen that can be spared from work at one time, the medical equipment of the plant, etc. The frequency with which they should be carried out is also a difficult question to decide, as I have so far been unable to discover any accurate studies which would throw any light on this question. In very hazardous occupations it is customary to make examinations at frequent intervals, even every month, but in the average plant they are made at intervals of one, two or three years, according to the judgment of the medical officer.

The industrial plant with a medical staff of its own should experience no difficulty in making periodic health examinations, provided they were taken into consideration at the time when the medical staff was organized, or provided the personnel is increased to permit their being made. They may be made continuously throughout the year, each employee reporting for re-examination about one year from the time of employment and again each succeeding year, or it may be less disturbing to conduct an intensive study of all employees within a short period of time, preferably during the slack season. For the latter method it may be necessary to have the examinations conducted by some outside agency in order to avoid interfering with the routine medical service of the plant.

The plant which has no regular medical officer or only a part-time physician will find it almost impossible to have periodic health examinations made without the help of some outside agency unless the number of employees is so small that the part-time physician can make the examinations along with his routine work.

The need for some organized agency, which could assist in the work of conducting health surveys and could serve as a group diagnostic center for obscure cases, so impressed the Henry Phipps Institute that it organized such a team of examiners and established a diagnostic clinic for the use of industrial plants in and about Philadelphia, the object being to provide a service which would cover all disabilities and not merely tuberculosis. The recent period of business depression seriously interfered with the health survey work but the diagnostic clinic is now in operation and is handling cases from several large industrial establishments.

Summary

In the foregoing paper I have attempted to give an outline of the tuberculosis problem as it affects the industrial worker. An unusual opportunity is here offered for the introduction of preventive measures, such as, for example, periodic health examinations, the results of which would be felt in the industries themselves and, if sufficiently widespread, would have a beneficial effect upon the health of the public. The review of the subject has also made evident the need for a more carefully developed and more uniform method of statistical report.

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CERTAIN ASPECTS OF THE PROBLEM OF ZINC TOXICITY*

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INTRODUCTION

THE toxicity, physiological action, and distribution of zinc and its compounds are of importance chiefly as the oxide, their most inert example. Finely powdered metallic zinc, as such, is not absorbed through the skin by handling and is encountered industrially only in the form of blue powder. There appears no evidence in the literature that ill effects from blue powder occur in the industries where it is used the most: namely, in sherardizing, in the cyanide process, and in the manufacture of certain dyes. Whether in the form of powder or spelter it is very generally, and with entire justice, classed as of no importance from the toxicological standpoint.

Isolated cases of skin lesions and burns from zinc chloride have been reported from time to time. Their nature and treatment are well understood and their occurrence can be ascribed to carelessness. Compounds such as the sulphate have no importance from the standpoint of industrial hygiene.

Zinc oxide is daily receiving greater industrial application. It is used extensively in the compounding of rubber goods, in the manufacture of paint, linoleum, oil cloth, glass and porcelain, in the preparation of zinc salts, especially the chloride, and in other less important industries.

BRASS FOUNDERS' AGUE

In several industries, of which brass manufacture is the best example, zinc is heated to a temperature at which it exerts a high vapor tension. The burning of this vapor then produces zinc oxide in a state of extreme particle fineness. The inhalation of the oxide in this condition has been held to cause the malady known under a variety of names, of which *brass founders' ague*, or more simply *the ague*, will be used hereafter.

Symptomatology.—More than seventy years ago descriptions of the ague appeared, and these have been accurately reaffirmed so often that they need but a brief word in addition. A few hours after exposure to air containing the freshly formed oxide, a dryness in the throat is noticed which gives rise to a tendency to cough. General lassitude, an oppression in the chest sometimes resulting in difficult breathing, and occasionally vomiting, are other early symptoms. After leaving the casting room, which is usually warmer than the outdoor air, chills are induced, ultimately developing into *shakes* with an attendant rise in temperature which passes off in a few hours with copious sweating. This series of events creates a desire for warm drinks, of which milk seems to be in the greatest favor. With the passing of the fever the patient sleeps soundly and arises the next day feeling slightly weak but not incapacitated for work. While the ague rarely causes absence from the foundries, it has been repeatedly reported that on Mondays and on days following holidays workmen are more susceptible—a fact which indicates that an immunity

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is developed by habituation to the fumes. Alcoholism is claimed by some as a factor enhancing individual susceptibility.

Treatment and Prevention.—No specific treatment has been shown to be universally effective. It is claimed that warm milk induces precipitation of zinc albuminates and thus rids the system of the cause of the ague, but this theory has by no means been proved. Although warm drinks may be of help, warm water would probably be about as effective.

It has been demonstrated repeatedly that good ventilation will prevent the ague. The problem should, therefore, be placed in the domain of preventive medicine, and the occurrence of trouble ascribed to ignorance or, more generally, to gross carelessness.

Thermophysics and Chemistry of Zinc Oxide Formation

In the medical literature on the ague there are many erroneous and unfortunate statements on the physical chemistry and metallurgy of zinc. These errors are so widespread and have appeared in so many articles and textbooks that it seems pertinent to this subject to discuss the more important factors governing the formation of zinc oxide. Furthermore, these factors are essential to an adequate understanding of the ague. Except in the splendid monograph by Gillett on "Brass-Furnace Practice in the United States" (1) —and this was written from the standpoints of metallurgy and metallography —no accurate accounts of the ague on the basis of the thermophysics and chemistry of zinc oxide have appeared in the literature. Gillett's work should have done much to dispel the errors which have appeared, but it has apparently not received the recognition which it has deserved. Although our knowledge has progressed since the publication of this monograph, there are so many valuable data compiled in it that free recourse has been had to its pages in the preparation of this article.

Heat of Formation of Zinc Oxide.—Pure zinc melts at 419.4° C. (2) and, under normal pressure of 760 mm., boils at between 920° and 930° C. (3), the exact boiling point still being subject to dispute. For convenience the range 920° to 930° will be used in this paper, and it is sufficiently accurate for the purposes intended.

To produce 1 gram-molecule of zinc oxide (81 gm.)[1] it is necessary to burn 65 gm. of zinc with 16 gm. of oxygen. If this is done calorimetrically in the laboratory, one starts and ends with all three substances at 0°C. or makes the calculations as if such were the case. This reaction results in the liberation of 84,800 calories. To have the reaction actually take place, however, either the zinc must be in a fine state of division, as is the case with blue powder, or else sufficient heat must be supplied. Once the reaction is started, it will proceed to the quantitative formation of zinc oxide, provided that there is ample oxygen present.

If zinc is boiled in an open crucible, of graphite for example, with walls sufficiently high so that the complete conversion of zinc vapor into the oxide does not take place until the vapor has risen above the mass of boiling liquid, sufficient heat to start the reaction is already present in the zinc vapor. Unless this heat, 36,345 calories (4), is added to the 84,800 calories representing the formation of zinc oxide with the reaction starting and ending at 0° C., a value below the correct one is obtained. The oxida-

[1] Decimals may be ignored.

tion of boiling zinc is, therefore, exothermic to the extent of 121,145 calories per gram-molecule of zinc oxide formed.

The fact that zinc vapor is quantitatively converted into the oxide, if the vaporization takes place in an oxidizing atmosphere, is the basis of the processes by which thousands of tons of oxide are produced today. If the reaction were not quantitative and other zinc compounds or metallic zinc formed, they would unfailingly appear in the chemically pure or even the commercial grades of oxide. The fact that such is not the case is well shown by the following analyses, kindly furnished by the New Jersey Zinc Company.[2]

ANALYSIS NO. 29078: SAMPLE OF ZINC OXIDE "SPECIAL"

Analysis on material as received:

	Per Cent.
Insol.	0.026
H_2O	0.244
CO_2	0.038
Total S as SO_3	0.240
Cl	0.036
PbO	0.096
CdO	0.023
Bi_2O_3	Absent
CuO	"
Fe_2O_3	0.017
MnO	0.006
As_2O_3	0.053
ZnO (difference)	99.199
Sb_2O_3	0.022

ANALYSIS NO. 40339: SAMPLE OF ZINC OXIDE "SELECTED"

Analysis on material as received:

	Per Cent.
Insol.	0.023
H_2O at 110°C.	0.230
CO_2	0.036
Total S as SO_3	0.224
Cl	0.067
PbO	0.094
CdO	0.019
Bi_2O_3	Under 0.001
CuO	" 0.001
Fe_2O_3	0.022
MnO	0.013
As_2O_3	0.036
ZnO (difference)	99.203
Sb_2O_3	0.033

[2] See also Hofman (5, p. 282).

In the commercial manufacture of zinc oxide two processes (5, p. 281), the French or indirect and the Wetherill or direct, are in general use. In the former, zinc vapor is burned as it issues from a battery of small retorts in which metallic zinc is boiled. In the Wetherill process, as applied by the New Jersey Zinc Company (6) at Palmerton, Pa., the source of zinc is oxidized ore in which the zinc may be considered present as the oxide to the extent of 18 to 22 per cent. Advantage is taken of the heat remaining in the furnace from the previous charge which, with forced draft, serves to ignite a layer of anthracite coal. On this is placed the oxidized ore intimately mixed with fine anthracite coal. The temperature used commercially for the reduction of zinc oxide is in the neighborhood of 1200° to 1300° C. (5, p. 37), so that the reduced zinc appears in the vapor and not in the metal state. Thus, the zinc oxide is first reduced to zinc vapor and then re-oxidized. The oxidation takes place above the charge bed and is complete when the fume enters the suction pipes leading to the bag filters, where the oxide is collected and packed for shipment.

Heat of Formation of Certain Other Metallic Oxides.—The burning of zinc quantitatively to its oxide has numerous analogies among other metals and particularly those entering into brass, the most widely used zinc alloy. To be comparable in their tendency to form oxides, their several heats of formation should be compared on the basis of equal weights of oxygen, of which 16 gm. gives a convenient unit. Calculated in this

manner for a few of the metals, we have the following (4):

Oxide	Per Gram-Molecule	Per 16 Gm. of Oxygen
	Calories	*Calories*
Mg.O	143,400	143,400
$Al_2.O_3$	392,600	130,500
Zn.O	84,800	84,800
Cd.O	66,300	66,300
$Sb_2.O_3$	166,900	55,633
Pb.O	50,800	50,800
$Cu_2.O$	43,800	43,800
Cu.O	37,700	37,700
$Pb.O_2$	63,400	31,700

The second reaction on this list is the basis of the Thermit process, in which the heat liberated by the burning of aluminium is sufficient to reduce iron oxide and furnish molten iron for welding. Of the zinc, cadmium, lead, and copper group, it will be seen that zinc heads the list by a considerable margin. Once the reaction is started it will, therefore, proceed with greater violence than in the cases of the other three metals.

Manufacture of Commercial Zinc or Spelter.—Owing to the facts that the temperature of reduction of zinc oxide is well above its boiling point and that the zinc vapor formed by such reduction oxidizes with extreme ease, zinc smelting cannot be carried out in the manner in which iron is reduced in the blast furnace.[3] The processes used today for the manufacture of metallic zinc are fundamentally the same everywhere. Zinc ore in the form of oxide, roasted sulphide, or carbonate, is mixed with approximately equal parts of a reducing agent such as anthracite coal, and placed in a small clay retort or still to which is attached a clay condenser. The still is heated by gas flame, and when the mass reaches the reducing temperature of zinc oxide, zinc vapor is evolved in the retort, passes to the condenser and is there condensed to the liquid. Oxidation always occurs to a slight extent in spite of the strongly reducing conditions, and some oxide is formed even in the condensers and is used in subsequent charges. Carbon monoxide results from the reduction of zinc oxide with carbon, and burns with the small amount of uncondensed zinc as both gases issue from the condenser.

The trifling quantity of oxide which forms in the condensers tends to condense the metallic zinc to the form of very fine droplets coated with a film of oxide. In the commercial production of blue powder the condenser is kept below the melting temperature of zinc. The blue powder formed is extremely fine and burns with great ease — with so much ease, in fact, that it is stored in a dry atmosphere to avoid fire hazard (5, p. 35).

Vapor Tension of Zinc and Certain Other Metals

If the vapor tensions of the metals are plotted with tensions as abscissae and absolute temperatures as ordinates, the curves are asymptotic with the x and y axes. This makes the interpolation of points at low pressures or high temperatures subject to great inaccuracy. If the logarithms of pressure are used as abscissae and inverse absolute temperatures as ordinates, the curves become approximately straight lines so that the accuracy of boiling-point determinations under various pressures can be checked by observing whether these points fall along the calculated straight lines. In this manner vapor-tension data of the metals have been collated and presented by Johnston (7). Curves from his data for copper, tin, lead, zinc, and cadmium are reproduced in Figure

[3] Attempts have been made to carry out such reductions at high pressures but with results of no commercial interest.

1. Considering the vapor tension of zinc under any temperature as an index of its tendency to volatilize, and, if in the air, to oxidize, this tendency can be computed from the curve. At the temperature of galvanizing (approximately 475° C.) zinc exerts a tension of 0.16 mm. (computed from the curve), while under boiling conditions its tension is 760 mm. Consequently the formation of oxide tends to proceed about 4,750 times

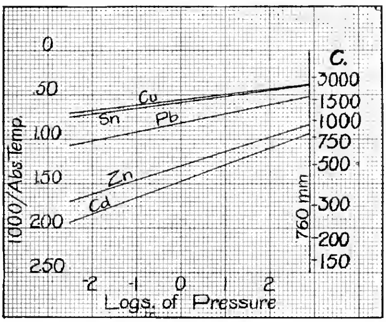

FIG. 1.—The vapor pressure of certain metals (7).

as rapidly when zinc is boiled as in ordinary galvanizing. Assuming that zinc oxide, formed by oxidation of vaporized zinc, is the cause of brass founders' ague, it should be many times easier for a case to be developed where zinc is being boiled than where the zinc is at the low temperatures used in galvanizing. That this is true in industrial practice is very generally admitted.

Cryoscopy of the System Cu:Zn.—In considering the vapor tension of the most familiar zinc alloy, brass, factors other than that of simple solutions enter into the problem. Cryoscopic curves for the system Cu:Zn have been determined and show that the melting points of the alloy lie between that of either metal. Copper melts at 1083° C. (2), and zinc at 419.4° C. Gillett (1, p. 131) gives 75 Cu: 25 Zn a melting point of 920° C., while 60 Cu: 40 Zn melts at about 890° C. By increasing or decreasing the percentage of either metal the melting point can be altered at will. In practice this is not strictly carried out since it has been shown that, with certain definite proportions, alloys of optimum tensile strengths, ductility, hardness, etc., are formed. Furthermore, metallographical observations have demonstrated that all of the zinc and copper present are united as a true alloy or solid solution only under limited conditions. When thus united it is probably correct to treat the system as a simple solution. The excess copper or zinc may then be considered to exert its own independent effect in the estimation of vapor tensions. For our purposes it is sufficient to consider brass as a true solution in all cases and to ignore the heat of formation of Cu:Zn, which is probably not great.

Vapor Tension of Brasses

The boiling point for copper is about 2350° C. (3), as compared with 920° to 930° C. for zinc. If cold zinc is added to molten copper it will quickly be heated to a temperature in the neighborhood of its boiling point. If we suppose the copper to be at a temperature of 1150° C., Johnston's curves show it to have a vapor tension of only 0.002 mm. The tendency for copper oxides to form from copper vapor at this temperature is, therefore, negligible compared with the oxidation of the zinc vapor which would exert practically its full tension of 760 mm.

When the zinc is all melted and mixed with the copper — and this occurs rapidly — we have a system which, like alcohol and water, boils at a point between the boiling temperatures of the two constituents, the tension of the mixture being the sum of the partial tensions of the

two metals. Hansen (8) has made several vapor-tension determinations for various brasses, and these determinations, with others, have been brought together by Gillett (1, p. 126). In a curve shown in Figure 2, Johnston (9) has used these data for plotting, taking as abscissae the percentages of zinc in brass, and as ordinates, the ratio between the measured or calculated pressure, P, of the brass to the pressure, P′, which the zinc alone would exert at the temperature in question. With this curve and his own vapor-tension calculations, Johnston (7) has also plotted the approximate vapor tensions of zinc in a number of brasses, the curves of which are reproduced in Figure 3. If, to these vapor-tension curves, we add that of copper, it will be seen that vaporization of this metal below a temperature of 1200° C. is too slight to be readable. This temperature is above that normally used in the melting and pouring of brass. Gillett (1, p. 259) believes that there is little or no copper in brass fumes from true volatilization, and that such as is found from fume analyses is due to mechanical entrainment with the zinc. This seems to be in accord with the theoretical evidence of the vapor-tension data.

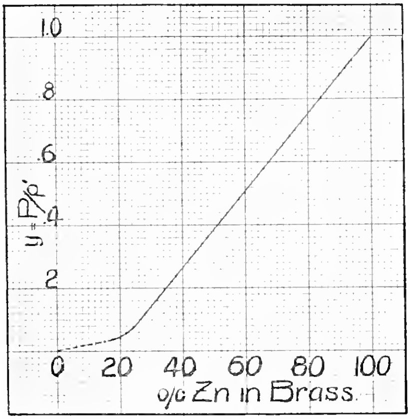

Fig. 2.—Ratios of the partial pressure of zinc in brasses to the pressures exerted by zinc alone (9).

If we consider brass to contain nothing but copper and zinc, Johnston's curves explain the greater evolution of zinc oxide from yellow brass with high zinc content than from the low zinc brasses. If it is desired to impoverish a given brass with respect to zinc, it is only necessary to keep the temperature sufficiently high to produce a requisite evolution of zinc-oxide fumes.

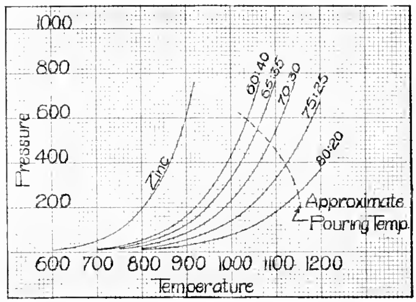

Fig. 3.—The approximate partial pressure of zinc from several brasses at various temperatures (9).

Manufacture of Brass

In the manufacture of brass in gas-heated furnaces or crucibles, the molten metal is covered with a layer of charcoal or coke, to which a little sodium chloride is usually added. Gillett (1, p. 141) states that covers for the crucibles help to keep down volatilization of the zinc but that they are seldom used. When a crucible is removed from the fire, a certain amount of zinc is burned to the oxide as the zinc vapors rise from the molten mass. When the charcoal cover is skimmed off or a cover removed, there is a more rapid evaporation of zinc

vapor — just as there is a more rapid evaporation when the cover is taken off a pot of boiling water. The zinc vapor rises and is burned as fast as it comes into contact with air. The oxide formed is of extreme fineness and readily floats upward by virtue of the convection currents caused by the heat from the crucible.

If the brass contains cadmium, this metal will, by virtue of its greater vapor tension, be more readily volatilized and burned than is zinc. At the expense of a considerable amount of zinc, brass can be impoverished with respect to cadmium simply by keeping the brass at a relatively high temperature. Lead, with a lower vapor tension than zinc, and tin, with a tension greater even than copper, are often used in alloys with zinc and copper. Theoretically, their volatilization and oxidation follow these same general principles, and the composition of the oxide fumes from molten alloys containing a mixture of all four metals can be approximated by curves made as are those of Johnston for simple brasses.[4]

In the electric furnace these same principles apply. Much higher temperatures, particularly in arc furnaces, can be reached, and volatilization correspondingly increased. For this reason careful temperature control is perhaps even more essential than in gas-heated furnaces, but at the same time the manipulation of the temperature is facilitated.

Composition of Brass Fumes.— We are concerned only with fumes at temperatures at which they can enter the nose and mouth without producing injury due to heat alone. To breathe fumes containing unoxidized zinc vapors requires their inhalation before they have reached the air and been burned to the oxide. Obviously this is not to be considered. There appears no evidence that it is possible to breathe fumes containing unoxidized metallic zinc of sufficient fineness to float upward with the air currents. Gillett (1, p. 259) says, "It is unlikely that metallic zinc reached the lungs unoxidized", and this, in the writer's opinion, is putting the matter conservatively.

Analyses of brass fumes show the presence of the several metals entering into commercial brasses in quantities and types of compounds, such as chlorides and sulphates, which can only be explained independently of vapor-tension calculations. Sodium-chloride covers probably increase the volatility of copper, for example, by forming copper chlorides. With none of these are we concerned, however, since it has been clearly proved that the ague can be produced by the inhalation of zinc oxide alone, and only under very definite and sharply limited conditions.

Volatility of Zinc Oxide.— It has been claimed by Kowalke (11) that zinc oxide is appreciably volatile at 1240° C. and can be completely volatilized at 1300° C. Since we are not dealing with air even remotely approaching these temperatures, it is improbable that Kowalke's work has any bearing on the ague.

A Review of the Literature on the Toxicity of Zinc Oxide

Introductory.—In a critical study of the medical literature on zinc oxide, considered in the light of our modern knowledge of the rôle and importance of the physical aspects of particle fineness, a number of striking discrepancies are apparent. Numerous clinical and experimental studies on the ingestion of zinc oxide have proceeded almost side by

[4] Bassett (10) claims that this is not so in practice and that both cadmium and lead are more rapidly volatilized than is zinc.

side with studies of the systemic effects from the inhalation of freshly burned zinc vapor. Reference will be found — indeed, in the earliest reliable reports on the ague — to the fineness of the particles. In one report, which will be discussed later, it was noticed that, when ingested, zinc oxide produced by the wet method and that produced by the dry method differed in their physiological effect. That the microscope might throw some light on the cause of the discrepancies between the results produced by the inhalation of freshly burned zinc oxide and those produced by the ingestion of ordinary oxide as taken from a bottle, seems to have been utterly ignored by even the most recent investigators.

Reports on the occurrence of the ague in the smelting and refining of zinc ores containing lead, arsenic, etc., are limited. Rather generally these reports contain statements upon the probable effects of lead or other impurities, and intimate that the impurities are of more importance than the zinc. Occasionally there have appeared evidences of the systemic effects resulting from the inhalation of brass and other metallic dusts having been confused with the ague. Although such reports are the exception, they cannot be ignored.

The medical literature on zinc oxide may be conveniently grouped in five distinct classes, under which it will be treated in this report:

1. Accounts prior to 1845.
2. Systemic effects from zinc oxide whether given internally or used externally.
3. Systemic effects from the inhalation of freshly burned zinc oxide.
4. General hygienic effects in the smelting of zinciferous ores.
5. Systemic effects from the inhalation of powdered brass.

Groups 2 and 3 are the most important, but for the sake of their chronology the classes may best be treated in the order given.

Accounts Prior to 1845. — There is abundant historical evidence of the skill of the ancients in gilding and in the manufacture and working of bronze, brass, and other alloys. Reliable metallurgical accounts, however, are lacking. In their recent translation of Agricola's "De Re Metallica" (1546), Mr. and Mrs. Hoover (12, p. 354) state that brass was made prior to the Christian era. On zinc oxide they quote Dioscorides (12, p. 215) (13), who described the manufacture and recovery of *pompholyx* (zinc oxide) and stated that it appeared at first like "bubbles of water, afterward increasing in size, it looks like skeins of wool," *lana philosophica* (philosophers' wool).

Fourcroy's (14) French edition of Ramazzini's classic (1700) on industrial hygiene contains accounts of lead colic, and mentions the fumes from gilding in boiling off the mercury in the amalgams, but it gives nothing definite on brass fumes.

According to Tanquerel des Planches (15), Guyton de Morveau (16), in 1781, was the first to advocate the use of zinc white in place of lead white for the manufacture of paint. After this date, therefore, we should expect to find accounts of the manufacture of zinc oxide and the occurrence of the ague in this industry.

Patissier (17), in 1822, described the old process of amalgam gilding and stated that "the oxidized vapors of copper and zinc" produce "colic often accompanied by *de douleurs terribles.*" Thackrah (18), in 1831, mentioned symptoms about like those of the ague and caused by the inhalation of freshly burned oxide. For this reason he is frequently said to be the first to have

recognized the condition as an entity.

Werneck (19), in 1831, appears to have been the first to describe systemic effects from internal doses of zinc oxide. Busse (20), in 1837, is cited by Michaelis (21) as having made a futile attempt to cure an epileptic with zinc oxide. It was not until many years later that this treatment was abandoned.

Systemic Effects from Zinc Oxide Given Internally and Used Externally. — In 1847, Heller (22) published an account of the internal administration of measured doses (20, 60, and 120 grains per day) of zinc oxide suspended in sugar solution. Heller seems to have observed no systemic effects, and concluded that not only was the oxide physiologically inert and, therefore, useless as a medicine, but that it was quantitatively recovered in the feces as the oxide, and that none appeared in the urine.

Schlossberger (23), in the next year, took exception to Heller's results and analytical methods, and particularly to his statements on the inertness of zinc oxide. Schlossberger showed that the oxide was appreciably soluble in weak acids, such as lactic and acetic acids, and in ammonium chloride solutions; and that it could be digested or dissolved by such media as pepsin hydrochloride. He also mentioned the insolubility of albuminate of zinc.

Bouvier (24), in 1850, reported a case of so-called *colique de zinc* in a patient, 42 years of age, engaged in packing and handling zinc oxide. While the symptoms were rather more violent than those ordinarily reported, they showed the expected systemic reaction occurring on the ingestion of zinc oxide. No lead or arsenic was detected in the dust from the patient's body and clothes — nothing but zinc oxide.

These reports appeared at about the time that the manufacture of zinc oxide in Europe was receiving much impetus through its successful use as a substitute for white lead in paint. Lead colic was well known — so well known, indeed, that reports on the effects of zinc oxide may have received unconscious color owing to the contagious influence of the numerous reports on lead poisoning. A report by Flandin (25), in 1850, is quite typical of this period. He made up pastes of zinc oxide and lead sulphate and applied them to the shaved hides of dogs. Apparently no precautions were taken to prevent the dogs from licking themselves and thus swallowing the pastes. The dogs rubbed with the lead pastes died shortly, while those treated with zinc oxide showed no ill effects. Flandin, therefore, concluded that the oxide was harmless externally, and that its use as a white lead substitute was fully warranted on the basis of the respective toxicities of the two substances.

Landouzy and Maumené (26), in the same year, described systemic effects from zinc oxide dust in seven men handling galvanized iron wires which had become coated with a film of oxide. When clean wires were used no further effects were noticed. No analyses of urine or feces are recorded.

Michaelis (21), in 1851, was the first to report an analytical technic for the determination of zinc in tissues, and on this technic he based the value of his results and conclusions. He differentiated between zinc oxide prepared by burning zinc and that prepared by igniting the hydroxide, but gave rather meager substantiation of the alleged difference. Moderate doses of oxide were given to the rabbit, cat, dog, and horse, and analyses of urine and feces were made, followed by postmortem examinations. Following his investigations on animals Michaelis took mild doses of

oxide himself, and described the results. The systemic effects were carefully noted, and may be summarized in his conclusions that the oxide was harmless in small doses, that large doses produced pronounced and definite effects due to the solubility of the oxide in the weak acids of the stomach, and that the compound formed was governed by this acid content. Hydrochloric and lactic acids were suggested as being the chief agents in producing solutions of the oxide. Diet was claimed to be the governing factor in controlling the compound formed. Finally, he concluded that if zinc oxide was of use internally, which he did not claim was the case, it should be administered as the lactate, acetate, or some other comparatively inert salt, and should not be used as the oxide, in which form it can too readily be converted into the chloride. If the oxide was used externally, he believed that acidity could play an important rôle in rendering it toxic.

Tardieu (27), in 1852, described the manufacture of zinc oxide and, from the hygienic point of view, gave it a clean bill of health. Bouchut's (28) account was similar in this respect but he reported instances of the ague among men engaged in roasting zinc ores for making the oxide. Its occurrence, he said, was limited to those actually in the immediate vicinity of the furnaces, and the resulting malady was so trivial that it did not incapacitate the men the next day. Because zinc oxide was used internally as a medicine he believed that it could result in no harmful effects if breathed or ingested. Marcet's (29) report, in 1855, should be considered as one of this group because he too believed that zinc oxide was beneficial as an internal medicine and as such was effective in cases of nervous disorders and epilepsy. He advocated doses of 30 grains daily and claimed that there were no ill effects except "slight sickness" and "constipation." This may be considered as quite typical of the general view then prevailing on the medical use of zinc oxide.

Of the systemic effects of large doses there are several examples. Spillmann (30) reported an instance of a patient's taking as much as 10 gm. in water. The effects were naturally violent but seemingly not fatal. D'Amore, Falcone, and Maramaldi (31) gave large doses of zinc oxide to dogs and furnished postmortem studies which showed a pronounced and vigorous effect on all the organs examined. Not only were the doses administered excessive, but they were unaccompanied by any sort of check on the diet. Instead of grading the doses by some method consistent with the animal's body weight, as was done by Michaelis, they gave as much as 1 gm. per day at the start and then diminished the quantity to 0.1 gm. after a few doses of the larger amount.

Sacher (13), in 1893, presented an extensive report on the action of zinc salts. He concluded that both the oxide and the carbonate were inert in small doses but that they exercised notable systemic effects in large doses. Lehmann's (32) investigations with zinc carbonate resulted in his concluding that it was comparatively inert. This salt is perhaps sufficiently like the oxide in its general solubility characteristics and inertness to justify their comparison on the basis of their physiological action. In making this comparison, however, the carbonate should be considered on the basis of the chemically equivalent amount of oxide. Converting Lehmann's figures of an average dose to the dog of 44 mg. of oxide per day per kilo body weight into the chemically equivalent amount of oxide gives

a figure of 28.5 mg. per day.[3] On this basis Lehmann's doses were less than the excessive doses of d'Amore and his co-workers, and about like those of Michaelis. The fact that the effects which he produced appeared negligible is probably thus accounted for and this finding does not conflict with the findings of Michaelis noted forty-six years previously. Stepp (33), in 1917, reported a case which, if there are no other factors entering in, is unique. To a patient suffering from eczema he prescribed the use of zinc oxide salve. Over a period of eighteen days 250 gm. were applied. Then the patient returned to the clinic, complaining of headache and difficulty in breathing. He showed a high pulse rate and had zinc in his urine. After twelve days in bed his condition was again normal. Stepp apparently did not consider the possibility of the patient's getting the oxide into his mouth through the agency of his hands, as is the ordinary course of events in the handling of white lead, and offered no explanation of the effects which undoubtedly seem to have been due to zinc oxide. This, however, is but a single instance and, so far as the writer is aware, the only one of its kind cited in the literature.

Bigelow (34), Salant, Rieger, and Treuthardt (35) have investigated the distribution and elimination of zinc salts. While their work has perhaps an indirect bearing only on the subject matter of this paper, it is of interest to note their conclusion that the bulk of the zinc is eliminated in the feces, traces only being found in the urine.

Turner (36) has reported what he styles as "occupational dermatoconiosis" produced from frictional skin infection with zinc oxide. From his own statements it appears that the infections, which were of a mild and unimportant type, were such as could be produced by excessive rubbing with almost any fine, dry inert powder. Zinc oxide and "its impurities" are considered as non-poisonous by Turner. His article, therefore, has no bearing on the toxicity of zinc oxide and is of no importance in this connection.

[3] One gm. of zinc carbonate is chemically equivalent to 0.649 gm. of zinc oxide.

Systemic Effects from Inhalation of Freshly Burned Zinc Oxide.—The cases of the so-called ague, which have been reported in the literature, may be grouped under this class. Since zinc oxide produces its most pronounced toxic effect when inhaled in the freshly burned state, this group is the most important. There are a great many reports of the occurrence of the ague. In spite of its general prevalence it was many years before the cause was positively identified. Many theories were advanced and, because zinc oxide was used as an internal medicine until a comparatively recent date, early investigators were loath to believe that it could be the cause of any systemic disorders. Since the ague was noted mainly in the brass industries, it was natural that copper should be frequently implicated as guilty in part, at least, of causing the malady to which men in poorly ventilated brass foundries were subject.

Beginning in 1845 there appeared a series of reports for the most part much alike and in general quite accurate. Blandet (37) furnished a good description of the method in which zinc oxide is produced in pouring brass, noted its fineness, pointed out that the ague was too well understood by the operatives to warrant their calling in medical assistance, and described the symptoms and course of the malady about as it is described in accounts appearing in recent times. Guérard (38)

discountenanced Blandet's hypotheses and rather naïvely attributed the causes to the drinking of too many lukewarm aqueous beverages. Then followed in rapid succession a series of reports which, in the main, agreed with Blandet. All advocated better ventilation as the surest remedy. One suggested that perhaps copper together with the zinc was the cause; another showed that lead was in the brass being cast. The authors included in this series were: Lévy (39) in 1845; Reboulleau (40) in 1847; Gardner (41) in 1848, who gave the first report in the United States; Chevallier and Boys de Loury (42) in 1850; Greenhow (43) in 1862; and Schnitzer (44), who presented the first German account. Because he was more emphatic, or perhaps because he wrote in English, Greenhow is the most frequently cited of this group.

In the original edition of his book in 1871 and in two subsequent editions, Hirt (45) suggested that copper and zinc together were responsible for the ague, and that the fact that the malady was not encountered in the ordinary metallurgy of zinc was proof of this hypothesis.

Popoff (46), in 1873, reported an unusual case. His patient was moved from other work to casting bronze and brass. Soon he became subject to attacks much resembling the ague, and after several weeks reported at Popoff's clinic. Together with other lesser disorders the patient had a pronounced internal tumor which may have caused him to describe his feelings in stronger terms than would have been used by a normal healthy individual. The interesting point is that Popoff found zinc in the man's urine a month and a half after he had been away from the foundry. Unfortunately, no control of diet was exercised.

Beginning in 1875 another distinct group of articles appeared, the authors of which cited from the existing literature but added nothing new: Layet (47) in 1875, Eulenberg (48) in 1876, Buck (49) in 1879, Lloyd (50) in 1880, and Poincaré (51) in 1886.

A good account of the ague was published by Simon (52), in 1888, and has been cited frequently by later writers. He believed that the malady was in no way chronic, that an immunity could be developed, and that both copper and zinc were responsible. Following Simon's article several more or less conventional and unimportant reports were published by various authors: namely, Arlidge (53) in 1892, Czajkowski (54) in 1893, Heinzerling (55) in 1894, Maher (56) and Oppenheimer (57) in 1895, Villaret (58) in 1896, and Sommerfeld (59) in 1898.

Hohmann (60), working with Lehmann, endeavored to produce the ague in animals by subjecting them to the fumes of freshly burned zinc oxide from both brass and zinc. While the procedure was a distinct step in the right direction their investigations did not bring forth their best results until a few years later. A copy of their questionnaire to brass founders is included in Hohmann's paper.

After Hohmann's report two unimportant contributions by Moyer and Lavin (61) and Sicard (62) appeared. Sigel (63) published an extensive report in 1906, in which he agreed with Lehmann's and Hohmann's conclusions that zinc was the cause of the ague. On its permanent effects he cited Popoff (46) who, as has already been brought out, gave a report on a brass founder afflicted with far more serious ills than the ague. Sigel stood beside the molds while castings were poured, caught the

ague, and described its progress in himself.

Lehmann (64), in 1906, showed that the ague could be produced from the burning of zinc alone. He and four others, one of whom was a caster who was said to be unusually susceptible, remained in a room where Merck's chemically pure zinc was vaporized and burned. Analysis of the room air showed the presence of 0.1 to 0.4 mg. of zinc oxide per liter. No zinc vapor or zinc peroxide was found. In this article Lehmann states that he can offer no explanation of the mechanism by which zinc oxide does harm, but suggests the possibility of the destructive action of the fine oxide on the epithelial cells of the respiratory passages. In this connection he has pointed out his repeated failures to produce analogous effects by the tracheal injection of zinc oxide. Lehmann's experiments have since received such wide recognition that they may be considered as generally accepted. In apparent ignorance of Lehmann's work, Perry (65), in 1907, claimed that no effects resulted from inhaling freshly burned zinc oxide, as he had done it frequently without suffering any harm. It was his opinion, therefore, that zinc oxide could not be the cause of the ague. He rather believed that the small amount of arsenic contained in commercial spelter was the cause.

Graeve (66), in 1907, described two cases in which the symptoms were so violent that he hesitated in placing the blame on zinc, and was of the opinion that further confirmation, which is nowhere furnished, was needed to settle the matter. Weyl (67) reviewed the existing opinions and gave examples of the prevalence of the ague in poorly ventilated shops which he compared on the basis of the heights of the ceilings, this giving a rough index of the adequacy of the ventilation. Roth's (68) account is quite in keeping with literature of that period and contains no new information.

In 1910, Lehmann (69) described more fully his earlier experiments (64) in which he showed that the ague could be produced by burning pure zinc.

Arnstein (70) has furnished a series of clinical reports on the effects experienced by himself and his assistants as a result of their having stood near the molds when brass, with zinc content of about 25 per cent., was being cast. He determined the zinc-oxide content in the air inhaled as 0.23 mg. per liter, which is a close approximation to Lehmann's (64) earlier figure of 0.1 to 0.4 mg. per liter. Arnstein found traces of zinc in the urine and appreciable amounts in the feces.

Kisskalt (71) claims that a more marked similarity exists between the effects produced by the inhalation of various heavy metal vapors than between those produced by introducing these same metals into the system by other means. Subcutaneous injections of zinc salts are said to cause a rise in body temperature experimentally demonstrable in animals. On this basis an analogy is drawn between the systemic effects of zinc, mercury, and copper.

Since the early experiments of Michaelis (21), von Jaksch's (72) rather extensive investigation is the first in which there is an attempt to explain the difference between the effects of ingesting ordinary zinc oxide and inhaling freshly burned oxide. He believes, like Michaelis, that the oxide is so insoluble that it must be converted into the chloride or lactate before it makes its action felt. Furthermore, he attempts to classify doses according to size and to the effects produced.

Bargeron (73) and Rambousek (74) gave the usual accounts of the ague. Pfender (75) mentioned its occurrence in oxyacetylene brazing, and Thompson (76) differentiated between the effects of inhaling metallic dusts and the effects of inhaling fresh zinc oxide fumes. Thompson's article contains some rather unfortunate misstatements on the volatility of copper, copper oxide, and zinc oxide.

Hayhurst (77) has written extensively on the ague. From the medical point of view his accounts are admirable and show evidence of much study and personal investigation into the general hygienic conditions prevailing in brass foundries. From the metallurgical and chemical side there are many inaccuracies. The hypothesis of zinc carbonyl as the cause of the ague has already been shown by Gillett (1, p. 259) to be totally untenable. Hayhurst's comparison or analogy between zinc oxide and zinc chloride on the basis of their hygroscopicities is entirely out of keeping with the well-known and totally different solubility characteristics of the two compounds. What he says of the searing action of zinc oxide would apply equally well to any other dry inert powder.

Oliver (78), in his "Diseases of Occupation" (1916), maintains his hypothesis of 1902 that zinc and copper together are responsible for the ague. Riesman and Boles (79) quote from Oliver in giving a review of the purely medical and hygienic aspects of the ague. Like Oliver they maintain that it can be effectively prevented by adequate ventilation.

Lehmann's (80) recent book contains a well-summarized account of his previous investigations and a clear exposition of his theory of the action of zinc oxide on the epithelial cells and bacteria of the respiratory passages.

Rost (81) discusses the general distribution of zinc in plant and animal life and points out the necessity of diet controls in considering the zinc content of urine and feces in men or animals living on normal mixed diet. In experiments with animals Rost (82) later shows that zinc oxide can be taken up in the lungs and ultimately excreted in the urine. Three dogs and two rabbits were placed together over the same mold in a brass foundry so that all inhaled air of about the same zinc-oxide content. One dog had been tracheotomized so that he could take in zinc oxide by the stomach alone; another had his esophagus closed off so that the zinc oxide could enter the lungs only. They showed fairly comparable systemic effects as to temperature, and both showed zinc in the urine with larger amounts, of course, in the feces. In themselves, Rost and his assistant had no difficulty in producing the ague, which they describe in the usual terms. Zinc was found in their urine for several days after exposure to the fumes.

General Hygienic Effects in Smelting of Zinciferous Ores.—While of interest from the point of view of general hygiene in ore smelting and metallurgical operations, reports in the literature coming under this classification are of little importance in considering the toxicity of zinc oxide. It is obvious that if we are dealing with the systemic effects of zinc oxide, the presence of metals other than zinc, unless in very definitely known amounts and under conditions thoroughly understood, renders the implication of zinc as the cause of possible poisonings a matter of extreme doubt. For this reason too much weight should not be given to reports of general smelting and refining of zinc.

In 1879 an article appeared by Schlockow (83), in which he rather incriminated zinc for certain ill effects noted among metallurgical workers. Tracinski's (84) account, in 1888, has in reality little to do with zinc, although it is frequently cited. Seiffert (85), Wutzdorff (86), and Frey (87) have all written on this general subject. The subject matter of their articles is really irrelevant to that under discussion and their papers are mentioned only because they are so frequently cited in the literature on zinc and the ague.

Systemic Effects from Inhalation of Powdered Brass.—In the early accounts of the ague references are sometimes made to systemic effects from the inhalation of brass powder, such as results from grinding and buffing of brass objects. Some writers have distinguished the ague by its lack of periodicity, the so-called *brass poisoning* being said to exhibit a type of periodicity as its outstanding feature. Regardless of the accuracy of either statement, effects from the inhalation of powdered brass and like copper or zinc alloys, whether serious or trivial, chronic or irregular, are not effects from zinc oxide and should not be confused with brass founders' ague. A typical report is that published by Hogben (88) in 1887. He defends the action of zinc oxide on the grounds that it has proved beneficial to patients, and believes that the "copper green line" exhibited by his patients, who were employed in brass-finishing work, was sufficient evidence that copper was to blame. Later reports by Murray (89) and Pietrowicz (90) are much like that of Hogben. These reports are mentioned only because the systemic effects which they describe have quite frequently been confused with the ague.

Comparison between Systemic Effects of Freshly Burned Zinc Oxide and of Normal Zinc Oxide Powder

From the physico-chemical and metallurgical standpoints there is no evidence whatever that the substance produced by burning vaporized zinc is anything but zinc oxide. Attempts to show the presence of any other zinc compounds resulting from this oxidation have given negative results.

That there is a very definite physiological difference in the effects produced by inhaling fumes of freshly burned zinc oxide and those produced by normal zinc oxide powder is shown by the numerous reports on the ague and the comparatively rare instances of systemic disturbances among men handling the powder. The recorded attempts to produce the ague artificially by the injection or ingestion of oxide powder have invariably given negative results. Well-defined systemic effects from swallowing oxide have been repeatedly produced and show that the magnitude of the effects vary in proportion to the amount of oxide taken into the system—small doses gave negligible results and large doses produced gastro-intestinal disorders and nephritis. In no instances are there recorded evidences of chills or fever. Inhalation of freshly burned oxide, no matter how produced, has invariably given rise to the ague and the characteristic symptoms with chills and fever. In both cases zinc is found in the urine and feces.

Comparison of doses of freshly burned oxide inhaled with doses of normal oxide powder ingested, on a weight basis, shows that doses of the powder have been given which are many times greater than the amounts taken into the

system by remaining from twenty to thirty minutes in close vicinity to a source of freshly burned oxide and breathing normally. From Arnstein's (70) figures of 0.23 mg. of zinc oxide per liter of air, in one hour, a normal individual at rest would inhale approximately 120.0 mg. of oxide.[6] Doses of oxide powder far exceeding this in weight have been given without producing anything like the same results.

Much of the oxide in an ordinary breath of air containing oxide of either type is undoubtedly mechanically stopped on its passage to the lungs, and, unless ejected by expectoration or coughing, ultimately reaches the stomach. The oxide which reaches the lungs must either remain there, be phagocytised and pass out by the lymph, or pass into the blood capillaries of the lung. Some may find its way up the trachea again and be swallowed.

That portion of the zinc, whether ingested or inhaled, appearing in the urine represents oxide which has been chemically acted upon and actually dissolved. Otherwise it would not appear in the urine. The zinc which is found in the feces is, in all probability, unchanged zinc oxide and has been truly inert—in the purely chemical sense. The ratios of the zinc appearing in the urine and feces are, from the accounts in the literature, varying quantities, as would be expected. The amount in the urine is invariably trifling compared to that in the feces. Whether or not the zinc in the urine represents all that which has produced a systemic effect is a matter of speculation on which present knowledge is insufficient.

Michaelis (21) explains the physiological effect of zinc oxide ingestions on the ground of zinc chloride formation. Lehmann (64) (69) (80) explains the ague effects from freshly burned zinc oxide as due to the destruction of the epithelial cells of the respiratory tract. Michaelis' explanation appears highly probable and would account for the effects noticed from oxide ingestions. Lehmann's theory places the fresh zinc oxide on the same footing as any other dry inert insoluble powder.

Particle Size.—It has been shown by Wells and Gerke (91) that particles of the order of 1 micron and less do not obey Stokes' law governing rates of settling in such media as air. This observation applied to individual and dispersed tobacco smoke particles which they estimated to be 0.273 microns in size. They found that time appeared to be a factor in the rate of particle flocculation, and plotted frequency curves to illustrate this point.

In the measurement and counting of small particles such as zinc oxide, Green (92) has pointed out the profound error caused by ignoring flocculation. He found zinc oxide particles to be of the order of 0.534 microns, or about twice the size that Wells and Gerke recorded for tobacco smoke particles. That zinc oxide, as taken from a bag or bottle, is flocculated to a high degree, will be disputed by no one who has ever compared it, even macroscopically, with the freshly burned oxide fumes.

Factors Affecting Particle Flocculation.—It is a matter of daily observation that humidity exerts a great influence in diminishing air dustiness. Katz, Longfellow, and Fieldner (93) have pointed out the necessity of using silica dust dried at a high temperature and dry air in the artificial production of dust clouds. This seemingly elementary but important fact has been con-

[6] This is allowing 500 c.c. per breath and seventeen breaths per minute. For a man undergoing vigorous physical exercise this quantity would be increased about two or three times.

firmed repeatedly by the writer with other fine powders much like silica in their adsorptive properties. Whether flocculation of the particles is caused by the adsorption of moisture alone, by electrostatic effects, or is an expression of some other effect, such as surface tension, has not, so far as the writer is aware, been definitely proved. On the facts, however, there can be no doubt—humidity exerts a marked effect on promoting particle flocculation. What the optimum conditions for producing flocculation are has yet to be determined and appears to be one of the most needed factors in the handling of dust problems.

Thoroughly dried dusts with which the writer has worked behave quite differently from those containing adsorbed moisture. The former are more dispersed and float about in the air much more readily and, on passing through glass or other tubes, have little tendency to adhere to the sides of the tube, even if there are numerous sharp bends. Flocculated particles, possessing the normal adsorbed moisture content, tend to deposit themselves on the walls of tubes and particularly at points where they are forced to undergo a marked change in direction.

Zinc oxide, freshly produced by the oxidation of vaporized zinc, is in the optimum condition of dispersion, and is inevitably dry. Consequently it is in the optimum condition to pass through the nose or mouth into the trachea and down into the lungs without coming into contact with the tracheal walls. If the particles reach the alveoli in the freshly burned dispersed state, they offer the maximum surface for phagocytosis and ultimate solution. When flocculated, they inevitably offer relatively less surface and are consequently less readily dissolved, since the speed with which particles are dissolved is a function of their surface area.

A Possible Explanation of Difference in Physiological Action of Zinc Oxides

Dispersion and absence of adsorbed moisture would appear, then, to be the main points of difference between the zinc oxide which produces the ague and that which does not. That there is a marked physical difference between these two types of oxide and that this difference is utilized commercially in oxide manufacture and collection is attested to by Breyer (94). If this physical difference in the state of the particles explains the difference in their physiological effects, it should be possible to show the degree and rate at which the factors producing flocculation gradually or abruptly bring the freshly burned oxide into the state in which it no longer produces the ague. This appears to be actually carried out in the manufacture of zinc oxide. Men working near the furnaces where the oxide comes off in the freshly burned state are subject to the ague; those in industries where this same oxide is handled and where zinc oxide is also inhaled do not complain of the ague. In both cases it is chemically zinc oxide and virtually pure. In the freshly burned state it is made up of dispersed particles. In the other state it is largely flocculated, undoubtedly lower in temperature, and contains some adsorbed moisture. Considered in this light the toxicity of zinc oxide is of interest and importance to the manufacturer, the clinician, and the industrial hygienist alike. Considered simply as a malady which can be avoided by adequate ventilation, the brass founders' ague appears to be of minor importance. In the latter case it is

very properly placed under the domain of preventive medicine, and its occurrence is ascribed to carelessness. In the former classification it can be regarded as a convenient link between fumes and dusts, and as such it offers an interesting and important problem on the effects of humidity, temperature, particle size, and flocculation on the collection of dust particles. This phase of the problem will form the subject of a future paper.

Summary

The physio-chemical factors governing the formation of zinc oxide are discussed, the conditions under which zinc oxide produces the brass founders' ague are described, and the literature on the toxicity of zinc oxide is reviewed. A distinction is drawn between the physical states of zinc oxide as inhaled from the burning of vaporized zinc and oxide powder of which the particles have become flocculated. On the basis of this difference in physical states, a possible explanation of the difference in physiological effects of the two types of oxide is offered.

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BOOK REVIEWS

THE NEWER KNOWLEDGE OF NUTRITION. THE USE OF FOOD FOR THE PRESERVATION OF VITALITY AND HEALTH. By *E. V. McCollum*, Ph.D., Sc.D., Professor of Chemical Hygiene in the School of Hygiene and Public Health, of the Johns Hopkins University, Baltimore, Md. Cloth. Second Edition. Pp. 449 with preface, table of contents, illustrations, and index. New York: The Macmillan Company, 1922.

THE average scientific man views with gratification a book which satisfactorily summarizes a vast amount of literature. Dr. McCollum has collected the most recent material on amino acid, inorganic salt, and vitamine needs, and has sorted, discussed and judged it. Everyone scientifically interested in metabolism should read this book, for it completes Lusk's "Science of Nutrition," and therefore furnishes a thorough summary of the hard-worked field of metabolism.

The book is not a textbook: the style is too chatty, and the evidence too detailed. A history of the development of the subject of nutrition is first presented, showing how ideas have crystallized and present theories developed. The new biologic methods for the analysis of foodstuffs, by which individual proteins of foods are tested on animals for their efficiency in producing growth and health, are thoroughly described. Equally as essential as the caloric content of foodstuffs —in regard to their physiologic effects—are vitamines and well-balanced variations in foods.

In a chapter on rickets, Dr. McCollum states that three dietary factors are concerned primarily in the development and normal metabolism of the skeletal tissues: phosphorus, calcium and vitamines. A contribution of great importance in this connection is the recent discovery by McCollum and others that "the ratio between the concentration of calcium and of phosphorus in the diet may, within certain limits, be of greater significance to the welfare of an animal than the absolute amounts of these substances which the diet contains."

Thus a very interesting, relatively new field of science is well epitomized. The statements made are based on experimental work: the book is replete with references. In addition to its scientific value, the book is a source of real pleasure.—*J. C. Aub.*

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A CRITICAL AGE AS A FACTOR IN LABOR TURNOVER*

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AMONG the problems of industrial management, that of high labor turnover is one of the most perplexing. Efforts to reduce it usually begin with a tabulation of its causes under such headings as economic (low wages, unsatisfactory modes of payment, etc.); physical (dampness, dirt, etc.); social (uncongenial supervisors or fellow-workmen); and physiological (fatigue and occupational disease). Still other causes are sometimes recognized as psychological, though not so openly, partly because they are hidden from ready view, partly because the technic of industrial psychology, by means of which the causes must be investigated, is so meagerly developed. While investigating some of these psychological causes, the writer encountered one which furnishes data by means of which not only certain cases of labor turnover, but possibly many other phenomena of industrial life, may be interpreted. This cause is a critical age period in a worker's life, during which time he quits his job with especial readiness.

The figures upon which this conclusion is founded were drawn from the service records of 2,500 workmen who quit consecutively, either voluntarily or involuntarily (almost all resignations were, of course, voluntary), in four firms during 1920. Two of these groups (metal workers, 297 of whom were in firm C, and 294 in firm D) were investigated by the Scott Company, Philadelphia.[1] The other two groups (A, consisting of 1,483 workers who left the employ of a metal-trades manufactory; and B, consisting of the first 500 men leaving the service of a furniture factory during 1920) were investigated by the writer.

The workers were classified into age groups at five-year intervals, the age recorded being that given at the time of hiring. The average number of weeks worked by the members of each age group was then calculated. (See Table 1.) In case a worker had been hired, had resigned, and had been rehired, the length of service was computed for the

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[1] The kindness of the Scott Company for permission to use the data reported in their Bulletin L. 4, Oct. 25, 1920, is gratefully acknowledged, as is the courteous co-operation of Messrs. Earl Chamberlain and R. W. Marshall, employment managers, who furnished the writer with data, and of Lee Crawley and Claude Campbell who assisted in the laborious work of tabulation.

period immediately preceding each resignation.

Results and Conclusions

1. The curves in Figure 1 show, first of all, a relatively short period of service on the part of workers under 25 years of age. This is to be expected, in view of the natural instability of youthful interests, the entirely worthy search for vocational objective, and the absence of the anchorage of economic and social responsibilities.

TABLE 1.—SHOWING NUMBER OF RESIGNATIONS AND AVERAGE NUMBER OF WEEKS SERVED IN DIFFERENT GROUPS.

Age	Number of Resignations		Average Number of Weeks	
	Co. A	Co. B	Co. A	Co. B
Under 21	271	204	18	10
21-25	341	96	19	9
26-30	296	60	23	11
31-35	231	30	31	24
36-40	155	38	28	19
41-45	84	26	29	12
46-50	72	17	30	8
51-55	17	12	58	15
Over 55	16	17	56	25
Totals	1,483	500		

2. The long service of workers over 50 is, of course, due to an opposite set of conditions: stability of interests, or habit, or recognition of the fact that gray hair is inimical to a favorable change of job.

3. With similar ease one can explain the long average period of service between the ages of 31 and 35, when men are rearing children and paying for a home.

4. Contrary to expectation, however, the length of service does not increase regularly with age. There comes a time when it decreases, namely, from 36 until 50 years of age, the minimum being reached between 41 and 50. In other words, this last-mentioned period appears to be a critical time when men give up their jobs with unusual frequency. This is manifest in the records of every one of these companies, although not so clearly in the case of company A as in the others. Indeed, the length of service for all ages is greater in this firm, probably because of the extraordinary measures which are taken to insure long service. By means of home visitation the company maintains

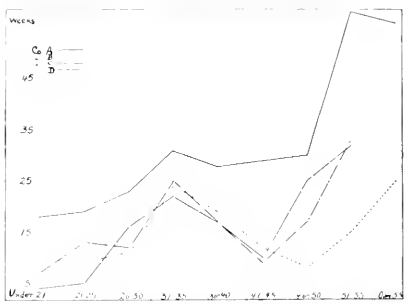

FIG. 1.—Showing average number of weeks worked by "quits" of various ages in four industrial establishments.

oversight over living conditions and applies remedies even to the extent of helping a workman find a better house. In 1920 it gave a bonus to all who remained more than three months. (It will be noted that even the age groups with the shortest term of service remained, on the average, four months—just long enough to receive this bonus.) That such solicitude for the physical and mental conditions of workers served to prolong the term of service in this plant appears unmistakable, especially in the case of the men at the critical age period, but it could not completely obliterate the effect of this critical age, for instead of rising regularly to the 55-year period, the curve takes the shape of a plateau.

The explanation of this critical age phenomenon gives rise to several interesting hypotheses. The first two to be offered are economic; the third is psychophysical.

1. By the time he has reached the age of 40, the laboring man has usually reared his children to the point where they can at least partially provide for themselves, and he has perhaps completed the payments on his house; consequently, he feels a degree of freedom in leaving one job to seek another.

2. Again, as he nears 40, he realizes that he is entering upon the period of declining strength and graying hair, when it will be increasingly difficult to secure a new job. And if he sees no further possibilities in his present job he feels that now is the time to make a change.

3. Apart from these economic considerations, however, there are others of a psychophysical nature. At this period there may be generating within the man certain deep-seated physiological changes. Just as woman at approximately the age of 45 undergoes the period of change known as the menopause—a period characterized by glandular and organic adjustments and psychic disturbances more or less serious in character—so the male, as he reaches the same age probably passes through a similar period. Because the symptoms are not so highly marked in the male, the occurrence of the phenomenon is not so universally recognized even by the medical profession. Mendel (1), however, and Church (2) called attention to it about a dozen years ago, alleging that it lasts from eighteen months to three years, and manifests itself in the following symptoms: high arterial tension, digestive and intestinal disorders, headaches, quick fatigue, oppressed feelings in the chest, sudden sensations of an alarming nature, specially vertigo. Most striking of all are the psychic accompaniments of the period: an almost invariable tendency to mental instability, sometimes leading to actual insanity, sometimes consisting merely of what Freud calls an "anxiety neurosis" (directed, perhaps, to the period of impotence which is due in ten or twenty years?).

It is interesting to note in this connection that the age at which persons coming down with senile dementia begin to come to state hospitals for mental diseases is between 40 and 49, and that patients suffering from general paralysis are admitted in greatest number between the ages of 40 and 49 (3).

We may reasonably believe, therefore, that there is a period in a man's life when he becomes especially unsettled mentally, and that this uneasiness expresses itself in the special frequency with which the men included in the investigation here reported quit their jobs.

Such a conclusion suggests that employers should exert considerable solicitude for men at this critical age; that they should be on the watch for symptoms of restlessness and irritability; that they should view these symptoms with toleration and sympathetic understanding; and that they should endeavor to take special remedial measures, such as giving increased responsibility, or more pay, or even a change of job, to those who are worthy. It suggests further that just as this critical age period affects the tendency of a man to quit his job, so may it affect him in other industrial relationships; even in other non-industrial respects, all of which should be investigated. The problem should be studied also in connection with workers in various classes of occupations.

Finally, the demonstration that such

obscure influences can be expressed quantitatively suggests that there may be others that can be demonstrated in the same way. Interesting speculations are advanced by economists who are desirous of bending the Freudian hypothesis to the ends of economic theorizing, to the effect that suppressed psychic forces operate to direct human beings at work. But before any hypotheses can be accepted, they must be subjected to the laborious investigation and quantification that have marked this demonstration of the relation between the critical age and labor turnover.

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POISONING BY BENZOL CARBON TETRACHLORIDE CEMENT, WITH SPECIAL REFERENCE TO THE EARLY SYMPTOMS OF BENZOL POISONING*

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THE freedom from fire risk attached to the combination of carbon tetrachloride with benzol appears to add to the industrial uses of the latter substance. The solvent properties of carbon tetrachloride and its cheapness likewise make of it a useful adjuvant when combined with benzol. Six months ago my attention was directed to some unfavorable effects resulting from a quickly drying, non-inflammable rubber cement in which this combination was found. Although the cement in question is said to have been on the market for a number of years, I have been unable to find in the literature, after a fairly careful search, any reference to the potential dangers associated with its use.

Injury to health from the use of the solvent, benzol, has been long recognized, especially on the continent of Europe, and was first reported in this country about twelve years ago (1). Numerous reports regarding the poisonous properties of benzol have since appeared in our literature. These have all been fully summarized in a recent article by Dr. Alice Hamilton (2). With only one possible exception, none of the American authors has dwelt upon the early symptoms of benzol poisoning. Nearly all the reports relate to cases that were either fatal or nearly so. It is believed that a more general acquaintance should be had with the early, less drastic symptoms of benzol poisoning, as they are hereafter set forth, especially in view of the importance of recognizing early symptoms in connection with preventive measures. After advanced symptoms have appeared much damage has been done and valuable time has been lost.

A brief review of the effects produced by carbon tetrachloride also seems justifiable because of its use in the cement in question and in view of the scattered literature on the subject, although it is not thought to have been a conspicuous factor in the cases reported in this article.

The cement referred to is manufactured for use in millinery establishments and thousands of cans are said to be sold throughout the United States and Canada. There is reason to believe that cement of this type has quite generally supplanted the needle and thread in some phases of hat making in the millinery industry. Economy in production now practically requires its use in certain processes. Hubbard and Kefauver (3), in 1920, published a rather complete report of conditions affecting health in the millinery industry. Benzol is mentioned, briefly only, among other poison hazards, but carbon tetrachloride is not included.

A Recent Factory Experience

In October, 1921, a case diagnosed as benzol poisoning was brought to the no-

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†Deceased June 21, 1922.

tice of our department. The illness affected a young woman employed as a hat maker in a wholesale millinery establishment. The symptoms described were severe gastralgia, irritation of the upper respiratory mucous membrane, headache, and tachycardia. About twenty girls were reported to be similarly affected. The following is a digest of the first-hand inquiry which was at once made.

The millinery establishment was housed in a long five-story building. Each end of the second floor and a portion of the fifth floor were partitioned off and equipped with tables, around each of which five or six girls were seated, engaged mostly in hat making. Open cans of cement were kept on the tables. Each girl reached forward, dipped a long-handled brush into a cement can, and then pasted cement on a buckram hat form held in her lap, while she pressed the cloth or other material into place. Until about eight years ago, these materials were always sewed into place. Facilities for natural ventilation were not the best and artificial means were not provided. The odor of benzol was quite distinct even at a distance from the partitioned rooms. The company officials stated that they had been using this brand of cement for about four years but had never before had any trouble with it.

The chief trouble arose coincident with the closing of the windows at the onset of cool weather. It was suggested that some change had been made in the formula of the last batch of cement purchased from the manufacturer. In answer to a letter of complaint, however, the manufacturer denied any change in the formula, but admitted that three other complaints had been made in the past regarding fumes from the cement. These disagreeable experiences were all ascribed by the manufacturer to faulty ventilation of the workplace and to physical ailments having no connection with the use of cement. In our chemist's analysis of the cement, sample A was taken from a can about half used, sample B from a new can freshly opened. The results were as follows:

	Sample A	Sample B
Residue on evaporation, largely rubber.......	% 3.60	% 3.11
Solvent:		
Carbon tetrachloride (CCl_4)	70.0[1]	66.0[1]
Benzine (benzol) (C_6H_6)	30.0[1]	34.0[1]
Carbon bisulphide (CS_2)	— —	0.05

[1]Per cent by volume.

Of the forty girls employed (all of whom were native white Americans), thirty-one were engaged in processes involving more or less exposure to cement fumes. Chief among these processes was one known as hat making, or securing cloth coverings and trimmings to buckram shapes by means of a quickly drying cement. Of the thirty-one girls more or less exposed, four, who were engaged in designing, machine operating, and cutting, did not handle cement. Two of these were, however, somewhat affected by the fumes. Twenty-two of the twenty-seven who handled cement had definite symptoms, the other five complained of no symptoms. All of the thirty-one girls were individually questioned in a quiet room secured for consultation through the courtesy of the managers who co-operated with the investigators in every way. The following brief case reports are presented as representative of the symptoms recited.

Case 1.—Miss ——, aged 21, a woman of rather delicate appearance, had worked as a hat maker in this establishment for about four months. She had had no noteworthy symptoms of poisoning until about three weeks previous to the investigation, but since then she had had attacks of nausea, accompanied by sensations of giddiness and faintness, on

account of which, one day, she could hardly reach her home. She complained of frequent urination and headache. She had used cloth masks over her mouth and nose when working with the cement, but had found them ineffectual. She gave no history of hemorrhages. She attributed the symptoms to the cement.

CASE 2.—Miss ——, aged 21, a woman of rather delicate appearance, had worked in the establishment as a hat maker and trimmer about fourteen months. About three weeks before the inquiry she became nauseated and very dizzy while at work. About ten days later at 4 o'clock in the afternoon she became dizzy and sick, and upon going home stayed in bed for twenty-four hours before she recovered. She was exceedingly weak and dizzy, and "could hardly get her breath." She claimed that she had never had such symptoms before, and that she always felt worse when she used much cement. She gave no history of hemorrhages or of "blue spots" on the body.

CASE 3.—Miss ——, aged 27, a maker, had worked in the establishment for sixteen months. A year previous to the inquiry her eyes had troubled her and she had been obliged to be fitted to glasses. A little more than two weeks before the investigation she became nauseated and her throat and stomach burned. Other symptoms were frequent urination, severe headache, and dizziness. Nearly every night she became worse after boarding the street car to go home, and during the evening nausea, giddiness, and weakness increased. She usually felt much better in the morning until she had worked for a short time. When further questioned on November 21, she stated that one evening about a month before, during an attack of nausea attributed to cement fumes, she had vomited about two teaspoonfuls of blood. This had never occurred before. She had had no stomach symptoms until a few weeks before this investigation. She claimed that she had noticed distinct bruise-like spots on her right thigh for which she could not account.

CASE 4.—Miss ——, aged 19, a maker, had used cement ever since entering the company's employment fifteen months before. She had noticed no symptoms until about three weeks before this inquiry, when she could keep no food on her stomach except toast and eggs. She suffered from giddiness and weakness, which she attributed to the cement. Just before leaving her work at night she always felt badly, and upon arrival at home she felt worse and often vomited. She said that her eyes and throat had burned a great deal in the previous three weeks, especially after she had opened [illegible] of [illegible]. She did [illegible] plain of frequent [illegible] had [illegible] hemorrhages.

CASE 5.—Miss ——, aged 2[illegible], [illegible] apparently strong and healthy, [illegible] in the establishment for seven [illegible] previously been employed at the same work. She stated that three weeks before the investigation she became nauseated and [illegible] while at work and in the evening at home. She always felt worse in the evening. One evening, two weeks after the first attack she became very ill on the way home, and that night vomited repeatedly until 12 o'clock. The vomit contained no blood, however. Her throat, chest, and stomach burned a great deal. She had noticed no effect on urination. Following this occurrence she was very weak and did no work for five days. The girl said that one of the other employees who had died about two weeks before had complained of similar symptoms caused by the cement.

CASE 6.—Mrs. ——, aged 42, who had been employed as a cutter for two years, had used a good deal of cement in pasting during the previous two months only. She often used it for two hours at a time, pasting as many as twenty hats in succession. She claimed that since she had worked with the cement she had been exhausted upon her arrival at home, that her throat felt sore and burned, and that her chest also felt sore. She complained of frequent urination when she used cement, and of dizzy spells. With cessation of the use of cement, she felt much better. She gave no history of hemorrhages or of "bruises" on the body.

CASE 7.—Miss ——, aged 37, a healthy appearing woman, had been employed with this company as a maker and trimmer for two years. Previously she had worked at the same employment in a retail establishment where less cement was used. She said that she always felt nauseated when the ventilation was poor. For three weeks she had had a burning sensation from "her tongue all the way down to her stomach." She had lost a half-day two weeks before and an entire day a week later "on account of cement." Of late she had been unable to eat tomatoes or anything acid. Eating seemed to hurt her stomach. She tasted cement after getting out into the air, and during the evening. At night she urinated frequently.

CASE 8.—Miss ——, aged 54, had been employed as a maker and trimmer for twenty years and had worked for this company [illegible] five years. She said that, although she [illegible] used cement for eight years, she ha[illegible] noticed any ill effects from it [illegible] weeks before. Since this time she had [illegible]

miserable with nausea and a burning sensation in the stomach. Her eyes burned and her heart action seemed to be affected; she also complained of a sense of faintness and weakness, and frequent urination.

CASE 9.—Miss ——, aged 37, a second-floor maker, had worked in this establishment for ten months and had had no ill effects until a short time before the inquiry. She had just returned from a week's absence on account of sickness which she attributed to cement, and had been ill for a week previously. Her symptoms were nausea and vomiting, gas on the stomach and bowels, and very sore bowels. Dizziness and weakness were more pronounced after she left the factory at night. She also complained that she had difficulty in breathing, that her chest was sore, and that her lips and throat burned. Before leaving work she had suffered from an itching inflammation on the ulnar surface of both forearms. This improved, however, while she was away from work, but recurred after she resumed work. She had always been strong, and looked well.

CASE 10.—Miss ——, aged 30, a maker, had worked for this company for eight months. The week previous to this investigation she had been severely nauseated. She had often felt so sick upon arriving at home that she had been obliged to retire immediately without eating her supper. Her forearms were superficially inflamed and her finger tips sore. The patient attributed all these symptoms to the cement.

The rather hasty physical examination of these cases necessitated by the circumstances gave practically negative results. Pulse and heart action at the time of examination were not disturbed. Mucous membranes in some cases were quite pale, in others normal. A conspicuous symptom was the burning sensation in the epigastrium, with tenderness on pressure. The blue spots on the thigh of Case 3 had disappeared at the time of a second examination (one month later). No disturbance of the menstrual function was elicited. Circumstances were not favorable for collecting blood samples. Except for the presence of cement no condition common to all the employees affected could be found to account for the symptoms. Inquiry into the death referred to by Case 5 indicated that death was due to a perforated gastric ulcer. There had been no confirmatory operative or postmortem findings. Moreover, the physician in charge of the case had not elicited the fact that the patient's illness was primarily associated with the breathing of cement fumes. In this connection it is perhaps significant that Sury-Bienz (4), Beinhauer (5), and others have found hemorrhages into the gastric mucosa in poisoning by benzol, and that Weiskotten and his collaborators (6), in careful experiments upon animals poisoned by benzol under conditions similar to those found in industry, found hemorrhages into the gastro-intestinal mucosa in three animals, and in one, small ulcers in the gastric mucosa.

While the author is of the opinion, after careful consideration, that the symptoms complained of by these patients were chiefly due to benzol, it would be inadvisable thus to dispose of the question of carbon tetrachloride without some reference to its systemic effects.

CARBON TETRACHLORIDE

Carbon tetrachloride came into general industrial use a number of years ago, partly as a result of improvements in its manufacture on a large scale, and partly because of its non-inflammability and its less toxic properties as compared with other solvents (carbon bisulphide, benzine, etc.). It is a heavy, colorless liquid, having an aromatic odor and a boiling point of 76.7 C. It is readily vaporized into a colorless vapor 5.33 times heavier than air. This property, together with its non-inflammability, makes it a most valuable agent in shutting out air from surfaces blanketed by it, and thus renders it useful in extinguishing fires.

Carbon tetrachloride first claimed the attention of the medical profession in December, 1865, when J. Y. Simpson (7) of Edinburgh suggested its use as a general anesthetic. Its alleged heart depressant properties, however, soon led to its abandonment. It was used as an agent for shampooing the hair in the early part of this century, but Colman (8) warned against its use, claiming that it was dangerous to life. Its action is similar to that of chloroform, though more depressant to circulation and respiration. In a footnote by Marshall to Colman's article, reference is made to the use of carbon tetrachloride in the sixties as an agent for the relief of headache, neuralgia, chorea, etc. Its ill effects caused it to be discontinued. There is recorded a case in which death took place very suddenly during the application of carbon tetrachloride in a dry shampoo (9). The presence of status lymphaticus in this case is said to have occasioned some doubt as to the true cause of death. Waller and Veley (10) concluded, from experimental studies, that carbon tetrachloride was considerably more toxic than chloroform. Rambousek (11) states that "carbon tetrachloride, so far as its poisonous qualities are concerned, is to be preferred to other extractives" such as carbon bisulphide, benzine, etc. "The narcotic effect is only half that of chloroform; it causes, however, a more violent excitation; inhaling the fumes brings on nausea, coughing, sickness, headache, etc."

Allison and Katz (12) found that the least concentration in the air of carbon tetrachloride, detectable by the olfactory sense, was 718 parts per million, and that when concentrated to the extent of 6,091 parts per million, the odor was "very strong." The authors point out that the soporific effect of carbon tetrachloride may account for the high concentration required before the odor is clearly detectable.

Lewin (13), discussing the effects of carbon tetrachloride, states that it is about twice as poisonous as chloroform; that, when a person inhales it, his breathing first becomes heavy, then he becomes delirious, is unable to stand, is nauseated and blue, and has dilated pupils. There is headache upon recovery.

Fieldner, Katz, and Kinney (14), in a recent bulletin of the Bureau of Mines, discuss the dangers associated with the use of carbon tetrachloride in fire extinguishers in confined places and upon heated surfaces. These dangers relate more particularly to the decomposition products of carbon tetrachloride (chlorine, phosgene, and hydrochloric acid gas). "Comparatively large amounts of carbon tetrachloride vapor must be breathed before the effects become dangerous." These authors quote Lehmann to the effect that "3,980 parts per million (about 0.4 per cent.) may be inhaled for about an hour without very serious effects."

Hall (15) directs attention to the utility of carbon tetrachloride as an anthelmintic when given by mouth in hard gelatin capsules for the removal of hookworms. He concludes that it is safer than other drugs used for this purpose, and indicates that the dangers ascribed to its inhalation have been overrated, a fact which "is perhaps responsible for the neglect of this drug for half a century."

Carbon bisulphide may be present in carbon tetrachloride as a residue resulting from the process of manufacture. It was not found in one of the samples of cement examined by us; it was present in the other, but not in an amount dangerous to health.

In considering the toxic properties of carbon tetrachloride a distinction must be made between its use as an anesthetic and its use as an industrial agent. Apparently fairly large amounts of the vapor must be breathed before toxic symptoms are produced. In none of the cases studied were the soporific effects ascribed to carbon tetrachloride noticeable. The weight of the vapor is such that, in the absence of any especial air movement, such as in the place under discussion, it would have a greater tendency than benzol to fall from its source toward the floor and away from the breathing level. The vapors of both agents, however, are quite diffusible, particularly benzol vapor. In utilizing carbon tetrachloride as a delousing agent, Foster (16) took advantage of the tendency of the vapor to fall to the bottom of a tall can in which infested clothing was placed. In the case of alleged death from carbon tetrachloride used for shampooing the hair, the conditions were most favorable for toxic effects as remarked by Marshall, the vapor naturally falling from above the breathing level directly over the face. This is a situation which could scarcely be imitated in ordinary industrial processes, and yet thousands of people are said to have had their heads shampooed with carbon tetrachloride without ill effects except in a few cases in which fainting took place (8).

By way of summarizing, it may be said that the danger of poisoning by carbon tetrachloride as used in the cement in question seems rather remote, though it may have contributed somewhat to the complex of symptoms.

Benzol

About two years ago Newton (17) described the case of a chemist, aged 30, who had been working two weeks with benzol, when he complained of headache, lassitude, loss of weight, pain in the abdomen, nausea, and vomiting. A physical examination proved negative. An examination of the blood, however, revealed a marked leukopenia. Two other chemists similarly exposed were without symptoms, but both had a marked leukopenia. Apparently this is the first case in the United States in which early subjective symptoms of benzol poisoning are described. No mention is made of irritation of the mucous membrane, or of bladder irritability (evidenced by frequent urination), as found in a number of the cases here presented. Lehmann, as quoted by Hamilton (2), found, in experimenting with cats, a decided variation of susceptibility to benzol in individuals, but, in all, signs of irritation of mucous membranes were present. Rambousek states that the fumes of benzol exercise a distinctly irritant effect upon the mucous membrane.

No mention of bladder irritability is found in the literature, as associated with poisoning either by benzol or by carbon tetrachloride. Jaffé (18) found muconic acid in the urine of dogs and rabbits which had been fed for some time with benzol. Brewer and Weiskotten (19) observe that it has long been known that benzol, when taken into the body, is oxidized at least in part to phenols by the body tissues, and that an appreciable amount of these phenols is excreted in the urine. Whether the elimination of these agents in the urine could account for the bladder irritability observed in a number of these cases is uncertain.

Early Diagnosis.—While the laboratory findings of Newton and his predecessors would give the impression that the leukocyte count is a dependable means of early diagnosis of industrial

benzol poisoning, the evidence is not yet conclusive on this point. Hektoen's experiments (20) indicate that there are certain exceptions to the rule, as far as leukopenia is concerned. At least, in benzenized rabbits leukopenia is not always produced, and in dogs reduction takes place only after hemorrhages and fatty changes have occurred. At the height of antibody production, benzol appears to have but little effect on the leukocytes in the circulating blood. Furthermore, were the procedure entirely reliable, there are many millinery establishments as well as other industrial concerns which are too small to afford the expense of repeated laboratory tests for the discovery of early evidences of benzol toxemia.

According to Thomas M. Legge (21), Burnet (Certifying Surgeon for Edinburgh East) regards hemorrhages from the mucous membranes of the gums and nose as an early symptom of benzol poisoning and one that can be safely used as a guide for the purpose of exclusion from work. Though hemorrhage from the nose and mouth may be accepted as a danger signal in benzol poisoning, the question may be raised as to the advisability of the general adoption of this sign as a sufficiently early signal for exclusion from work. Can we be certain, for instance, in any given case, that earlier hemorrhage has not been concealed in some internal organ before its external manifestation? If one may draw any conclusions from the cases here presented, in which but one patient showed any evidence of hemorrhage, it appears that well-defined symptoms are produced by benzol long before hemorrhage of the nose and mouth is produced, or before any evidences of subcutaneous capillary leakage (purpura) appear. These early symptoms should receive more attention.

It is true that in these cases most of the symptoms are subjective in character, but in dealing with an agent as poisonous as benzol some notice should certainly be taken of a set of concurrent subjective symptoms as similar as were those here described, in persons working under the same conditions. Moreover, the recognition of the early symptoms of disease is a most important factor in prevention. It is essential, therefore, that employers, safety men, and physicians should have a more general acquaintance with the early symptoms of benzol poisoning, so that preventive measures may be taken before serious damage is done.

While benzol was manufactured in the United States for many years before the war, chiefly by the Barrett Company, the relative cheapness of petroleum benzine greatly restricted its use. The demand during the war for the manufacture of American explosives and dyes stimulated the production of benzol and its homologues. The armistice, as Dr. Hamilton states, left the producers with the problem of finding new markets for their products. That the new markets have been found is shown by the expenditure of millions of dollars by the steel plants in the installation of by-product coke ovens, from which our chief supply of benzol is derived. Although benzol is now more expensive than it was before the war, the petroleum product, benzine, judging from market quotations, has so greatly increased in price that benzol can be purchased at least as cheaply as benzine. The great superiority of benzol over benzine for many industrial purposes further accounts for the present popularity of benzol.

In their report on industrial poisons, prepared at the request of the committee of the International Association for

Labor Legislation, Sommerfeld and Fischer (22) point out that female workers, particularly in their developmental years and especially at the time of menstruation, are more susceptible to benzol poisoning than are men, and are susceptible in an extraordinary degree to the subacute and chronic forms. The authors advise the exclusion of women from every employment in which benzol is used. Women are, nevertheless, increasingly exposed to benzol in American industry. To attempt to prohibit its use on account of the effect on some individuals seems to be out of the question. Efforts might better be directed toward educating employers and others responsible for factory conditions to the importance of adequate general ventilation of workrooms where benzol is used, and to the early symptoms of poisoning by it. Great caution should be observed in using it in closely confined quarters. Its utility in millinery cement depends largely upon its rapid and complete vaporization. It is probable that local exhaust ventilation is not so feasible as dilution by adequate, general forced ventilation, the air being exhausted from workrooms preferably through openings or gratings in the floor. The production of toxic symptoms in laboratory animals (rabbits, dogs, and cats) exposed to benzol fumes in concentrations of 2.4 to 5.7 parts per 100,000 of air (Rambousek), as well as observations on man, suggests the advisability of not permitting benzol fumes to accumulate in workrooms to an extent greater than 1 part per 100,000 of air.

Instructions regarding ventilation should be printed on the label of every container holding benzol in any quantity which might, under unfavorable conditions, cause symptoms. The manufacturer of the cement in question has kindly agreed to place such instructions on all labels printed in the future.

Many brands of cement are on the market. Besides millinery cement, there are cements designed to secure rubber to rubber, leather to leather, and rubber to leather, and there are numerous fabric cements. It is probable that most of the superior ones depend upon the solvent action of benzol and its rapid vaporization when once applied. Careful analysis of one sample yielded benzol forming 49.5 per cent. by volume of the total solvent, and analysis of another, 76 per cent. One sample claimed by the agent to be of inferior quality contained no benzol, the solvent consisting entirely of petroleum ether (high test gasoline). Still another brand contained only 8 per cent. of benzol, the remainder of the solvent—92 per cent.—consisting of the poisonous solvent, carbon bisulphide.

It is doubtful whether the occasional use of benzol cements is injurious to health, but when their use becomes more or less continuous, especially in confined quarters and with the absence of abundant ventilation, toxic symptoms may be expected, and should be recognized before advanced tissue changes develop.

Summary

My objects in presenting this article are:

1. To direct attention to the importance of such early and relatively mild symptoms of benzol intoxication as irritation of the mucous membrane of the upper respiratory tract, nausea, vomiting, burning sensation in the epigastrium, frequent urination, giddiness, slight air hunger, and weakness. These symptoms have a tendency to grow worse after an affected person leaves the atmosphere of the factory.

2. To point out the bearing on industrial health of the increased use of ben-

zol afforded by its combination with carbon tetrachloride in a non-inflammable mixture.

3. To direct attention to the importance of safeguards for the protection of employees, especially women, who handle benzol.

4. To urge the advisability of printing in conspicuous type on the label of every container holding benzol a caution concerning the importance of adequate ventilation in places where benzol is used.

5. To assemble a fairly complete bibliography on the systemic effect of carbon tetrachloride.

On account of the rapidity with which benzol vaporizes and the difficulty of confining its application to a small area, at least in the millinery industry, efficient exhaust ventilation should be carefully studied. It is probable that local exhaust ventilation is not so feasible or reliable in many processes as dilution by means of forced general ventilation, the air being removed from the workroom in a downward direction through floor gratings.

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DIAGNOSIS AND SUPERVISION OF INDUSTRIAL DISEASES IN GERMANY*

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At the cradle of every modern movement for industrial hygiene have stood physicians. In England in 1796 Dr. Percival called attention to the fearful consequences of child labor and gave impetus to the first English child labor laws. Likewise in Prussia thirty years later, it was the reports of the military surgeons on the decline in military fitness of the inhabitants of the Rhenish industrial districts, which led to the first Prussian child labor laws (1839). For the administration of these laws local police, teachers, and clergy were responsible. Not until the law of 1853 was provision made that, when necessary, supervision should be carried out by factory inspectors. In England similar laws led to the extensive co-operation of physicians in industrial supervision, inasmuch as the apparent age of the children could be legally established only by a medical certificate. In Prussia and Germany, where the Civil Registry was already highly organized, proof of age followed upon presentation of certificates of birth and baptism.

Although the earliest instructions for factory inspectors emphasized the necessity for hygienic supervision of workrooms, nevertheless the control of child labor (which alone was regulated by law) was entirely a police measure, particularly as the first factory inspectors were minor police officials. As technical science advanced, accident prevention assumed the more important place, and as a result technical men were, for the most part, appointed inspectors. The present Prussian regulations regarding the training of factory inspectors (dating from 1891) require that all applicants pass a state examination as engineer or chemist. This requirement naturally excludes physicians from inspection of factories. The local health official, the district physician, has not the right to make factory visits on his own authority, but must communicate with the factory inspection officials. In the sanctioning of new factory projects he is obliged to assist in the examination of the specifications, but he can visit the proposed site for this purpose only on official invitation. At the same time he is so burdened with other official duties that his activity in the field of industrial hygiene must be extremely limited. This explains the fact that while factory construction and accident prevention have made enormous progress in Germany, thanks to the tireless efforts of technical inspectors, and particularly in the Rheinlands have reached a height which is not equaled in Austria, Belgium or Italy, and which, so far as I can deduce from the literature, is not surpassed in any other country, nevertheless, industrial diseases have not received the consideration which unfortunately they demand.

It is in the supervision of occupations which are hazardous to health that physicians can least of all be dispensed with; their services have always been required, although hitherto to an

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insufficient degree. As long ago as 1847 the Middle Frankish Government (Bavaria) requested the municipal council of Fürth, the center of the mercury mirror industry, to co-operate with the government physician and the factory owners in establishing protective measures against the harmful action of mercury on the health of the workers. This resulted in the issuing of an order by the municipal council, in 1853, that no one without an official medical certificate should be accepted as a worker in a mirror quicksilvering establishment; in addition, the government ordered that the workers in these plants should be given a medical examination every three months, and that health instruction should be provided by government physicians. In 1858 employers were made responsible for the keeping of an accurate record of workers entering and leaving their employ. A move in a somewhat different direction was the ordinance of 1877 issued by the chief of police on the occasion of the establishment of a mirror silvering factory in Berlin. This ordinance required that the factory owner refer his workmen to a definite physician for regular care and continuous observation, and that sickness records be kept.

Thus were laid the foundations for medical supervision which, in the following years, was prescribed for a number of occupations hazardous to health (match factories in Prussia, May 13, 1884; lead paint and lead acetate factories in Prussia, April 12, 1886; and mirror factories in Prussia and Bavaria in 1889). In these trades the employment of workers is permitted only on the presentation of a medical certificate of health. Moreover, the employer is required (1) to entrust the supervision of the health of his employees to a physician, whose name is to be sent to the industrial supervision officers and who at regular prescribed intervals shall inspect the employees; and (2) to keep a record of men entering and leaving his employ, of sickness, and the results of the periodic examination of every workman.

The unsatisfactory aspect of these regulations lies in the fact that it is a physician engaged by the employer to whom the supervision of the workers' health and, indirectly, the hygienic condition of the manufacturing processes are entrusted. Dismissal of workmen from the factory and significant entries in regard to unfavorable health conditions attract the attention of the government industrial inspectors; and this results in further hygienic regulation. It is thus easy to understand why many an employer prefers a physician who notices little that is unfavorable, and who makes his examinations and entries perfunctorily, merely to satisfy the legal requirements; and why, on the other hand, a conscientious physician sometimes makes himself unpopular with his employer.

In order to assure government authorities a certain influence over the employment of the examining physician, later legislation (first in 1905 in a regulation regarding lead smelters) required that the examination be entrusted by the employer to a physician authorized for that purpose by the government, whose name must be reported to the government industrial supervision officers. In the latest law (relating to lead color works, January 27, 1920) a further step has been taken: "Authorization is granted only when the physician has obligated himself to carry out the instructions prepared by the Ministry of Labor," and "if the employer wishes to discharge a physician entrusted with

the supervision of his employees' health, he must first file a notice with the state authorities giving his reasons." This seems a further step toward making the examining physician somewhat more independent of his employer; and it is to be hoped that the work will soon be carried on by physicians who are entirely independent.

Medical supervision of employees (in addition to physical examinations on entry) is at the present time prescribed for the following industries:

Lead smelters, at least once a month (law of June 16, 1905).

Zinc smelters and zinc roasting furnaces, at least once a month (December 13, 1912).

Storage battery plants, at least once a month (May 16, 1908).

Manufacture of alkaline chromates, at least once a month (May 16, 1907).

Nitro and amido compounds, preparation or recovery, at least once a month (1911).

Thomas slag, at least once a month (July 3, 1909, and December 23, 1911).

Preparation of lead colors and other lead compounds, at least twice a month (January 27, 1920).

Painters and paint workers in connection with other industrial processes, at least every half year (June 27, 1905).

Vulcanizing of rubber goods, at least once a month (March 1, 1902).

There has been a further step in another direction in requiring medical co-operation. In certain factories, before the admission of young persons—at least to certain processes—medical opinion as to their fitness for the work is required. Here, too, it is a physician engaged by the employer who decides whether young persons shall be allowed to engage in the work, and, if so, which applicants are fitted for employment. Medical examination before employment in factories or in particular processes is prescribed as follows:

For girls of 16 to 18 years of age before employment in collieries, zinc and lead ore works, and coke works in the Oppeln district (under certain conditions). (Decrees of March 24, 1892, March 20, 1902, and April 12, 1907.)

For young male applicants for work in collieries (under certain conditions). (March 7, 1913.)

For young male applicants for work in rolling mills and forges (under certain conditions). (May 20, 1912.)

For young male applicants for work in certain processes in glass furnaces, glass polishing and glass etching plants. (March 9, 1913.)

It should here be stated that the great chemical establishments of Germany have installed in their plants physicians who, having the opportunity to study the diseases occurring in that industry, have thereby acquired an intimate acquaintance with the rarer forms of industrial disease, and have enriched the German literature on the subject through numerous valuable contributions.

The industrial supervision officers frequently publish information about the prevailing industrial diseases, based on the above-mentioned records. As far as one can generalize from particular cases, however, the figures given must be lower than the actual number. Take for example an investigation by the district physician at Kattowitz, in 1909, into the physical condition of workers in zinc smelters. He examined the working personnel of smelters where no cases of sickness had been reported for several years, and found symptoms of lead poisoning in 20.5 per cent. of the workers examined. Through questions he was able to elicit little specific information about earlier sickness, as

the workers interviewed were apparently fearful that if they gave too detailed answers they might lose their positions, and consequently were reluctant to answer.

For many years the figures of the industrial inspectors have been based on the cases reported to them by the sickness insurance offices. Sickness insurance for workmen has been compulsory in Germany since 1884. The changes effected in the sickness insurance law by the State Insurance Law make it obligatory for the presidents of sickness insurance offices to furnish the industrial supervisors, on request, information in regard to the number and character of the diseases which they have recorded. Although this law did not go into effect until January 1, 1914, as early as 1912 the Prussian industrial supervisors, on the basis of a ministerial decree, applied to the sickness insurance offices for information, and requested the reporting of cases of poisoning by lead, mercury, arsenic, and phosphorus. Bavaria went further and required the reporting of a number of other poisons. It is, however, generally acknowledged that the notifications are incompletely made and that they contain a large number of errors in diagnosis. Consequently, we must accept the figures from these sources with a great deal of hesitancy.

At this point some data for the year 1912 will be given since conditions were considerably changed during the war as a result of various circumstances—namely, the lack of lead compounds, the greater preoccupation of physicians with other tasks, the absence on military duty of a number of factory inspectors, and the imposition on the others of tasks made necessary by war conditions. According to the latest reports which are available, conditions have not yet returned to normal. In 1913, however, the reports contained but few data on industrial poisoning because an unusually full report on the subject was made in 1912. The Bavarian district industrial physician — whose services I shall mention later—sent out a questionnaire to the various hospitals in Bavaria for the purpose of securing a report of cases of industrial poisoning. The replies reported 126 cases of lead poisoning in painters, 1 case of mercury poisoning, 9 cases of arsenic poisoning, 238 cases of eczema, and 375 cases with symptoms of fatigue or exhaustion (deformities, tenosynovitis). In the last four months of the year, since the introduction of compulsory reporting, the Bavarian sickness insurance offices reported 170 cases of lead poisoning, 4 of poisoning with benzine, benzol, and carbon disulphide, and 16 cases of poisoning with nitro and amido compounds. In the Potsdam district (Prussia), 138 cases of lead poisoning were reported to the industrial supervisors. Fifty-five cases of lead colic and paralysis were reported among the zinc-smelter workers of the Oppeln district, and 33 cases among lead-smelter workers. In the lead industries of the Wiesbaden district there were 153 cases of poisoning, of which 108 occurred in smelters; in the Düsseldorf district 3 cases were reported among a total of 644 zinc-smelter workers, and 8 cases among a total of 648 lead workers. Among 763 workers, the average number employed during the year in the lead paint factories of the Cologne district, 126 cases of sickness due to lead occurred. From Saxony 148 cases of lead poisoning were reported. I have selected only a few figures from the reports; further enumeration would be tiresome as would also accounts of individual cases of poisoning with sub-

stances other than lead. Francke states that in the short fraction of the year 1912 for which the sickness insurance offices made their returns, in spite of the incompleteness of the reports, 1,119 cases of lead poisoning (lead line, or suspicious cases not included) came to the notice of the industrial supervision officers as compared with 174 in 1911, and 93 in 1910. Subsequently 564 cases were reported for 1911 and 526 for 1910, making the totals for these two years 738 and 619, respectively.

The only industrial disease which has been reportable universally throughout Germany (not only actual cases of the disease but suspected cases as well), and for the reporting of which the physician giving treatment is responsible, is anthrax. (Law in regard to the control of communicable diseases in effect June 30, 1900.) In its industrial origin it is included in the term "Accident," and it has been considered an industrial injury and has been compensable under workmen's accident insurance legislation operative since 1884. The Imperial Insurance Law of 1911 gave the imperial councillor (now Minister of Labor) the right to extend accident insurance to include certain industrial diseases. By the decree of October 12, 1917, the award of insurance and pensions to dependents in cases of fatal poisoning by aromatic nitro compounds—the chief poisons of the war industries—was allowed, and thereby a partial equality of these diseases with accidents was attained.

The introduction of obligatory reporting of industrial diseases is at present under discussion, and is being studied by the Central Government. The Institute of Industrial Hygiene at Frankfort-am-Main has published a questionnaire on the subject worked up by Francke and Bachfeld (Berlin, Julius Springer, 1921). Opinions are widely divergent; one group, especially the representatives of the workmen, seeks compulsory notification, while others—and I myself am of this group—have serious doubts as to the advisability of such a measure. We fear—and not unjustly, I believe,—that incomplete reporting of industrial diseases will lead to an undervaluation of the frequency and, consequently, of the significance of these diseases. The main difficulty, however, is that examination of the reported cases and confirmation of the diagnosis must take place, if industrial hygienic measures are to be founded on the reports; and yet this is only possible when there exists a sufficient number of authorized physicians experienced in dealing with industrial diseases, who by virtue of their training are in a position to draw conclusions as to the hygienic measures necessary, and to recommend improvements in processes or in safety devices. It is not merely a matter of industrial hygiene in its narrower sense; industrial diseases, in the opinion of many, should be compensated in the same way as industrial accidents. Out of common justice and in accordance with the principle of compensation for loss of working power due to dangerous occupations, which is the basis of accident insurance, this opinion seems to be well founded. (Compare my report to the International Workmen's Insurance Congress in Rome, 1908.) The placing of industrial diseases on a basis with accidents presupposes, however, that the diagnosis be confirmed as soon as possible, particularly in cases of acute illness, for if confirmation of the diagnosis is deferred until some later time,

[1]Francke, E.: Die gewerblichen Metallvergiftungen in Preussen nach dem Jahresbericht der Gewerbeaufsicht für 1912. Zentralbl. f. Gewerbehyg., 1913, *1*, 392.

the facts of the case can rarely be established. In order to make the early confirmation of the diagnosis possible, therefore, a large staff of physicians trained in industrial diseases is necessary.

Although many suppose that compulsory reporting of industrial diseases will pave the way for equal treatment of diseases and accidents before the law, I am of the opposite opinion. It is only legal equality that will be sufficient reason for compulsory reporting. Who will be interested in carrying out the notification if no one derives any immediate profit? The employer will always find notification a hardship on account of the possible change in his manufacturing system which may result from it; the workman will not be interested because it may often cause him to be temporarily inconvenienced through exclusion from his work; to the physician it is only a nuisance. If, then, there is no one who has any interest in the preparation of the report, it will not infrequently be neglected. It is different when the workman knows that a legal claim can be founded on the notification; then he will take care that the notification is carried out. As I have already stated, however, there must be on hand an experienced physician who can immediately confirm the diagnosis.

I have explained that inspection of factories in Prussia, and in almost all other parts of Germany as well, has until recently been exclusively in the hands of engineers. The number of physicians active in factory inspection in Germany is very small. Württemberg, in 1905, and Alsace-Lorraine, in 1906, assigned to a health officer in the public employ the duty of hygienic adviser to the industrial supervision office. In 1906 Baden had a physician, Dr. Holtzmann, who was factory inspector in charge of the common factory inspection and who, in addition, filled the position of medical adviser to the factory inspection service. In 1912 he was appointed Chief Official Industrial Physician. In 1909 Bavaria appointed Dr. F. Koelsch state industrial physician and his sphere of activity has extended throughout the whole country and over all factories subject to the Industrial Supervision Office. He is expert adviser of the government and the supervision office; he co-operates in the enforcement of workmen's protection laws by revision of industrial processes, and by organization and supervision of the examining physicians. Further belonging to his duties are investigations in industrial hygiene in preparation for new laws and regulations, scientific work, examination of groups of workers and laboratory work. In the thirteen years of his activity in science and in practice, he has accomplished a vast amount. In spite of the excellent results obtained in Bavaria, not until 1920 did another German state, Saxony, appoint a state industrial physician, Dr. Thiele. Recently, however, Prussia has come to the fore by naming five state industrial physicians whose authority and whose duties will be similar to those of the Bavarian state industrial physician. As the first of these, I began my work four months ago.

If industrial diseases are to be really understood and, through an understanding of them, a basis for their prevention established; if compulsory reporting is to be carried out in a satisfactory manner; and if an identical handling of industrial diseases and accidents is to be brought about, then development of medical co-operation in the field of industrial hygiene and of industrial supervision must be extended

in at least two directions for which the foundations already mentioned exist in Germany: (1) increase in the number and the independence of examining physicians, to whose care is entrusted the supervision of the health of workers in the various hazardous industries; and (2) increase in the number of physicians employed in actual industrial supervision. This is the preliminary step toward all further progress in this field, and it seems now as if this progress would be made possible in the near future.

INDUSTRIAL DISEASES OF FUR CUTTERS AND HATTERS*

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MERCURIALISM

THE descriptions of industrial mercurialism as found in the textbooks cannot be applied to the disease as seen in hatters without some modification, for these descriptions are based on studies of trades in which the exposure to mercury is greater and the form of poisoning more intense and rapid. Such trades are mercury mining, backing mirrors with mercury, fire gilding, and manufacturing mercurial compounds. The hatter is exposed for many years to very small quantities of mercury, and the form of intoxication produced, except in very bad shops, is slow to develop and lacking in some of the more striking manifestations of typical chronic mercurialism.

Symptoms

Mouth.—According to Tylecote (1), the most characteristic findings in the mercurialism of hatters are in the mouth, although in a typical case there is little or no salivation. Six out of eight of Taylor's (2) cases had no salivation, and Monti (3) thinks that dryness of the mouth is usual, with perhaps an occasional attack of salivation. Teleky (4) says that mercurialism in hatters is characterized by tremor without salivation. Glibert (5) also believes that an excessive secretion of saliva is unusual in this form of industrial mercurialism. All of the five severe cases described by Adler (6) had profuse salivation, but it is rare to find so rapidly developing and extreme a form of intoxication in this trade as was shown by his cases.

The odor of the breath is said to be recognizable by the expert and is usually described as metallic, but in serious cases it may be fetid. Often the gums are spongy, redder than normal, and bleeding easily. The tongue is described by Tylecote as large, dove-colored or silvery, flabby, and showing indentations from the teeth. Sommerbrodt (7) says that an early sign is the appearance of localized white spots on the mucosa surrounded by bluish or reddened areas, "pharyngeal hydrargyrosis." Various descriptions are given of the mercurial line which is occasionally observed along the margin of the teeth. According to Monti, it simulates quite closely the Burtonian lead line but is more brownish; Adler calls it bluish; Glibert, a dirty red—rarely blue; and Tylecote describes it, not as granular, but as an almost uniform purplish line along the swollen margin of the gums. Glibert has never seen it in carrotters, only in workers who handle carrotted fur. Among 468 workers he saw a typical Burtonian line with bluish patches on the mucosa of the cheeks in fifty-seven or 12.1 per cent.

The teeth are often blackened, especially the upper and lower incisors of carrotters exposed to the acid fumes. Sizers show this effect on the teeth also, but not so frequently. Glibert says that the women in the Belgian fur cutting trade brush their teeth more than the men do and they suffer more from in-

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flamed gums than do the men, although their teeth are much less black. The enamel of the teeth is eroded and decay follows. As pyorrhea sets in with retraction of the gums, the teeth loosen and fall, the upper molars going first (8). The older workers in Italian and French and Czecho-Slovak factories are practically toothless, according to my observations, and, from their own account, the loss of their teeth was quite painless. Monti had a case of necrosis of the right lower maxillary bone, necessitating operation.

Tremor.—Teleky, Monti, Taylor, Harris (9), and most of the French writers consider the presence of tremors as the most characteristic sign of mercurialism in hatters, while Tylecote thinks the characteristic signs are to be found in the mouth; Glibert finds tremors and mouth lesions present with practically the same frequency. In Taylor's cases, the course of the disease was slow and insidious, and the first symptom noted by the workers was tremor. The characteristics of mercurial tremor are as follows: It is a fine trembling of the muscles which, according to Teleky, is typically interrupted every few minutes by coarse, shaking movements. When the hands are stretched out, with fingers spread, the tremor is seen distinctly, then diminishes as the man becomes accustomed to the position, and may die away for a minute, only to start up again. Tylecote says the fineness of the tremor has been overstated; it is coarser than that of exophthalmic goiter or of alcoholism. Taylor's tracings showed eight per second. It is not so regular as that of alcoholism or of paralysis agitans, and another distinction between the latter and mercurial tremor, according to Erben (10), is that in mercurial tremor it is the whole hand which trembles, while in paralysis agitans each finger has its own movement. The tremor begins usually in the fingers but in the early stages can often be seen in the eyelids when the eyes are closed, in the lips when they are drawn back to expose the teeth, and in the protruded tongue. It is an intention tremor, increasing as efforts are made to control it and increasing with precision of movement. For instance, if a glass of water is put into the outstretched hand, the tremor increases; and it becomes even greater if an attempt is made to carry the glass to the mouth. It tends to die down during rest—in this respect it differs from senile palsy—and even in extreme cases it stops during sleep. There are no sensory symptoms accompanying it, although there may be some numbness and profuse sweating of the palms.

As the case progresses, the tremor passes to the arms and then to the legs, which may jerk and jump, especially when they are swung forward in walking. In one of Adler's cases, the feet knocked against each other as the man walked. Going up and down stairs becomes especially difficult; a boy seen by the investigators for the Civic Federation (11) could get downstairs only by sitting down and lowering his body from step to step. It is very difficult to walk a narrow path and, in several instances described to me, a workman who was still capable of carrying on his trade, the motions of which had become almost automatic, could not reach his workbench alone but had to be guided by a fellow-workman along the narrow aisle between the whirling belts of the machinery. There is a famous case of "hatters' shakes" in Orange, N. J., a man who kept on at work long after he had developed severe tremors. He could not feed himself nor dress himself, and the only way that he could get to work

was by pushing before him a baby carriage which served to steady his gait. When he reached the plant he would be guided to his bench, and then he was able to carry on the work familiar to him through years of practice.

In severe cases, the tremor is generalized. The five men seen by Adler had involvement of all the muscles, except those of chewing and swallowing, and Gilman Thompson (12) saw a case of generalized tremor in a hatter, as severe as paralysis agitans. Speech is affected, becoming hesitating or stuttering and thick but not staccato. The handwriting may be like that in paralysis agitans. The knee jerk is usually overactive, but there is no ankle clonus. Stiffness of the muscles and difficult flexion of the elbow have been described. According to Glibert, Letulle found a loss of strength, especially of the flexors of the arms and the fingers, but Glibert was not able to confirm this, although he found an indication of weakness of the extensors. Teleky saw two cases of radial palsy. The tremor usually passes away if the patient can be induced to give up his work before it has reached a serious stage, but in any hatting center there are histories told of men who had the "shakes" for years after quitting the shop. Teleky saw one case in which the tremors had lasted fifteen years, and another in which they had lasted thirty years. A man in Danbury had typical tremors for thirty years.

Tylecote calls attention to the possibility of an acute attack in the course of chronic poisoning in an old worker; as, for instance, a hatter, twenty-five years in the trade, who had a typical acute intoxication with salivation, diarrhea, and bloody stools. It was not till after he had recovered from this that his tremors began. Tylecote has also seen an apparent immunity break down if a man returns to work too soon after some weakening illness.

Psychic Symptoms.—Kussmaul's *erythismus mercurialis* (psychic irritability of a high grade) is not marked in the mercurial poisoning of hatters. Teleky says that psychic changes are rare, and that there is, at the most, only lassitude and weariness. Tylecote finds "nervousness" common, and he and others describe loss of memory, dullness of the intellect, drowsiness by day and insomnia at night, lack of self-control and poise, easily aroused anger, and causeless embarrassment. The most marked instances of psychic disturbance in the literature of mercurialism among hatters are to be found in the Civic Federation's (11) report of the industry in New York City and vicinity. In fourteen of the eighty cases studied, there are noted such symptoms as insomnia, depression, and melancholia, sometimes with suicidal tendency.

Gastro-Intestinal Tract.—No characteristic symptoms are found here, perhaps because in this industry the mercury does not enter the body through ingestion, but through the respiratory tract, and excretion seems to take place chiefly through the lower intestine. Tylecote says that diarrhea is unusual, and Adler did not find it once in his five severe cases. Constipation is much more common. Taylor saw no signs of gastro-intestinal irritation, but Schoull (13) found gastric disturbances among French hatters and a curious change in appetite, a distaste for nitrogenous food and a craving for vegetables, spicy foods, and acids. Monti says that Italian hatters acquire a distaste for red wine.

Skin.—Carrotters may suffer from the effect of nitric acid on the skin, and sizers, who in some factories are required to add the dye to the sizing kettle, complain of inflammation of the

fingers, especially around the nails. A true mercurial dermatitis, such as may occur after mercurial inunctions, is rare. Schoull says that carrotters often suffer from obstinate dermatoses; Gilman Thompson has seen several cases of eczema in hatters; Schütte (14) makes a general statement as to eczema being common in the industry, but Teleky has seen no industrial exanthem in hatters, and Tylecote says that, although cracks and fissures may be caused by the acid added to the hot water, he has never seen erythema or papular eruptions.

Urine and Blood.—There is a difference of opinion with regard to urinary findings. Monti finds polyuria; Tylecote says that scanty urine, sometimes with quite normal constituents, occurs too often to be accidental. Both say that albuminuria is rare, mercury having not nearly so damaging an effect on the kidney or on the blood vessels as lead. Monti says that the kidney may eliminate mercury for a long period without albumin appearing in the urine. On the other hand, both Teleky and Harris found albuminuria in a large number of cases. Mercury has been isolated from the urine of hatters by Monti, but Taylor could not find it in either urine or feces.

There is nothing characteristic in the blood. The red cells are likely to be diminished moderately and there is a slightly greater loss of hemoglobin, but stippled cells are not found. The differential count of whites shows an increase of lymphocytes at the expense of the polymorphonuclears, so that sometimes the relation between the two is actually reversed, but, according to Agasse-Lafont and Heim (15), this sign appears too late to help in the diagnosis, rather it is of grave prognosis. There is nothing to distinguish the blood of early mercurial poisoning from that of other metallic poisonings and, if any striking changes are found, they indicate profound impregnation with mercury.

Prevalence of Mercurialism in Hatters

The quantity of mercury to which hatters' furriers and hat makers are exposed is, as we have seen, slight, yet this industry is looked upon by Europeans as one of the worst of the poisonous trades, calling for strict regulation and, according to many writers, for the total prohibition of acid nitrate of mercury as a felting agent. (See Chaplet (16).)

France.—It is in French literature especially that one finds gloomy pictures of the men and women in the fur cutting trade, and many efforts have been made in France to introduce a non-mercurial carrotting fluid. The discussion begins with Hillairet's (17) paper, read before the Academy of Medicine in 1869, on the evils of mercurialism among hatters, although prior to that time several men had tried to find a substitute for mercury, the first effort being apparently the use of sulphuric acid by Guichardière in 1817 (16). From 1869 on, the subject has never been dropped except for a temporary suspension during the war. In 1892, Jungfleisch (18) brought the matter again before the Academy of Medicine, saying "We all know the terrible accidents to which are exposed the workers in this industry . . . mercurial poisoning continues to decimate the fur cutters." In 1907, Espanet (19) spoke before the third Congress of the *Association Ouvrière pour l'Hygiène des Travailleurs* on the dangers of this trade, and, as a result, the Congress petitioned the Department of Labor to take measures for the suppression of the use of mercury. Since all that fol-

lowed was a law prescribing certain precautions in fur-cutting plants, Martial (20), in 1911, being profoundly impressed with the dangers inherent in mercurial carrot, revived the agitation against its use. Martial had investigated fur-cutting shops and had found a great deal of mercurialism. There were in 1911, he says, from 500 to 600 members of the hatters' syndicate in Paris. Two hundred and fifty of these were hatters' furriers, and 60 per cent. of them he found to be affected with mercurialism. The mortality from mercurialism was 2 to 3 per cent. per year. Martial himself examined forty-nine persons working at the time and found evidence of mercurial poisoning in twenty, although this was during the slack season when only the best workers were left. All carrotters, he believes, acquire mercurialism within five years' time, and, of the others, about 30 per cent. are poisoned in five to fifteen years, 10 per cent. after fifteen years. He says: "Nobody of course thinks of denying the shocking (*néfastes*) effects of the acid nitrate of mercury. Everyone knows it is a poison and recognizes the damage it causes."

The French law of 1898 is very detailed. It forbids the employment of anyone under 18 years of age in carrotting or in plucking or cutting, if there is much dust. The employment of women is likewise prohibited. The law requires floors to be of impermeable material, clean and in good condition, and the walls also. The carrotting fluid must be made only at night and in a separate room. Exhausts must carry off the vapors from the drying rooms, and the rooms in which skins are stored, carrotted, blown, and cut must be abundantly ventilated. Carrotters must wear gloves of rubber or heavy leather, and for all who handle the skins after carrotting the employer must fur[nish] a suit of washable working clot[hes]. Wash basins and soap must be provided and a separate lunch room; no food may be kept or eaten in a workroom. A doctor must examine once in three months all workers who come in contact with carrotted fur and, if signs of mercurialism are detected, the worker must be shifted to work which will not expose him further. Yet the French sanitarians regard these safeguards as inadequate, and they are leading a movement to prohibit the use of mercury in felt hat manufacture, just as they led the movement against the use of white phosphorus in the match industry, and the use of white lead in paint.

I was in France in the summer of 1921 and was permitted to visit fur-cutting shops in Vincennes. One feature of the French method is distinctly dangerous and suggests one reason why the trade has so bad a reputation in that country. Drying the carrotted skins is accomplished in rooms heated by a brazier of burning coke or charcoal, which may raise the temperature to 112° F. (44.4° C.), or even to 165° F. (74° C.). The skins are carried in and hung for a couple of hours or overnight, according to the kind of carrot desired, and then the workers go in and carry them out again. Inasmuch as the greater part of the mercury is said to pass off during the drying process, the danger of this method is obvious, and the French government has recently forbidden its use, but has allowed time for compliance with the new law. In one of these French plants, I saw an old woman working on raw skins right beside the open door of the drying room.

Belgium.—There are two descriptions of the making of felt hats as carried on in Belgium, both by Glibert (5) who has long been connected with the Depart-

ment of Labor of Belgium. The first was given before the International Congress of Hygiene in Brussels in 1903, the second before the same congress held in Washington in 1912.

The industry in Belgium has a very bad reputation. It is, in part, a home industry, poorly paid, and carried on by the very lowest class of the community. There is one step in the preparation of skins for carrotting which can be done by hand better than by machinery, but it is only in Belgium that workmen can be found to do, on a large scale, this hand work, which consists in plucking out the long stiff hairs so as to leave only the fine fur behind. It is impossible to do this as well by machine; Belgium is, consequently, the source of hand-plucked skins for the rest of the world.

The various processes in the preparation of hatters' fur in Belgium are chiefly in the hands of women, except for carrotting, which is always done by men. Glibert found that the average length of employment for the men was nine years and four months, and for women, seven years and five months. He made a careful comparison of the health records of women in the fur cutting trade and of women in textile work in the linen mills, and found that there was little difference between them. On the other hand, the men carrotters have a high sickness rate and 66.67 per cent. of those examined by him showed symptoms of mercurialism — namely, tremor in 61.9 per cent., stomatitis in 11.12 per cent., and anemia in 9.5 per cent. Examination of women employed in the processes which expose them to contact with mercury — brushing, cutting, and blowing the carrotted fur — gave these results:

Occupation	Mercurialism %	Tremor %	Stomatitis %	Anemia %
Brushers	47.16	28.80	27.12	5.08
Cutters	13.00	25.55	24.23	3.52
Blowers	44.58	32.53	31.33	7.23

Among the blowers who did not show symptoms at the time, 20.34 per cent. gave a history of symptoms in the past. The men suffered more from tremor, probably because of alcoholism, which was frequent among them but rare among the women. The presence of these symptoms did not always mean loss of health; in fact, 57.49 per cent. of those with signs of mercurialism were in good general health. The condition of the factory had a decided influence on the amount of industrial poisoning. For instance, a comparison between a good, a medium, and a bad factory gave the following results: average amount of poisoning in a good factory, 37.21 per cent.; in a medium factory, 56.25 per cent.; in a bad factory, 88.89 per cent.

The following table gives the percentage of cases of mercurialism in men and women according to the length of employment:

Length of Exposure Years	Women with Mercurialism %	Men with Mercurialism %
Up to 5	34.48	54.26
Up to 10	46.84	52.00
Up to 20	60.71	66.67
Up to 30	57.14	100.00
Up to 35	100.00	66.00

At the International Congress of Hygiene in Washington in 1912, Glibert presented another report, not so complete, the gist of which can be given in the following table:

Occupation	Sex	No.	Health Good	Health Mediocre	Health Bad
Before carrotting	men	705	91.91	7.80	0.28
	women	938	84.21	15.68	0.11
Carrotting	men	88	63.64	31.82	4.54
After carrotting	men	44	77.37	22.72	—
	women	435	68.96	28.96	9.00

Great Britain.—At the Brussels Congress of 1903, the felt hat industry of Great Britain was described by T. M. Legge, Chief Medical Inspector of Factories and Workshops. The occurrence of mercurialism among hatters had been brought to the attention of the govern-

ment toward the end of the last century by the appearance of several cases of marked poisoning among women. An investigation was ordered and a detailed report was submitted by three women inspectors, Miss Deane, Miss Squire, and Miss Patterson in 1898 (21). Pronounced cases of mercurialism were not found to be numerous but serious outbreaks did occur occasionally. From the description by these authors it is plain that the usual method of drying the skins in British factories at that time was on racks in heated rooms, and, while in some factories the racks could be drawn out, in others the skins were carried out by hand. The cutting departments were said to be very dusty, and in one there had been an outbreak of mercurialism among the women. "Locking"—*i.e.*, sorting out the inferior pieces from freshly cut fur—was said to be bad. The women lockers had to protect their wedding rings against the action of the mercury. In passing, I may say that I have never been able to find the wedding ring of a sorter in an American factory showing any such effect.

Legge visited these same factories in 1900 and examined some of the workers. Among twenty-one women who had worked from one to seventeen years, he found only a single case of mercurial tremors, but in another factory nine out of seventeen had tremors. This last group had all worked at least ten years. Carrotters suffer more from nitric acid fumes, others from mercurialism, as this table (8) shows:

	No. Examined	Bad Teeth	Tremors
		%	%
Carrotters	30	66.6	3.3
Other processes..	81	33.3	21.0

Mercurial poisoning was brought under the law requiring notification of cases in May, 1899, and by December, 1918, 208 cases had been reported. However, only forty-six of these came from the hatters' trade, twenty-seven from the hatters' furriers, and nineteen from the hatters. Forty-six in almost twenty years does not indicate any great danger of mercurialism in the British hat industry. According to Porter (22), writing in 1902, there is very little mercurialism in the making of hats as distinguished from fur cutting. Stockport is the center of hat making, not fur cutting, and in this city observations carried on by Porter show that dust, especially that produced by pouncing (smoothing the hat with sandpaper), is the worst evil, mercurialism being negligible. Stockport hatters, according to Porter, have a tuberculosis rate 63 per cent. in excess of the average. On the other hand, Tylecote (1) of Manchester, another large hat center, presented a paper before the International Congress for Hygiene at the meeting in Washington in 1912. He said that, while mercurialism among hatters' furriers had long been a matter of common knowledge, it had been recognized among hat makers only to a slight extent, and the cases notified had come almost entirely from among furriers. His attention was called to mercurialism in hat makers by a case of what he had at first supposed to be disseminated sclerosis in a "stover," a man employed in heating shaped hats at 180° F. Analyses made for him by W. M. Gardner of Bradford showed the presence of 0.138 per cent. of mercury in the finished hat. After this Tylecote saw twenty more cases of mercurialism in hatters, all men, as no women are employed in these plants. Two were in youths. Fur blowers inhale mercury-laden dust; plankers—sizers, as we call them—soaking and working felt, are exposed to moist heat which is favorable to the absorption of

mercury through the skin, the respiratory tract, and the digestive tract. Taylor (2) found that a piece of fur from the cutting machine contained 1.34 per cent. of mercury.

Germany.—The felt hat industry has not been as fully studied in Germany as in most countries. Indeed, it seems to have attracted less attention than any other industry involving the use of a poisonous substance. There is a section devoted to it in Weyl's Handbuch der Arbeiterkrankheiten, by P. Schütte (14) of Magdeburg, but the information given is general in character, and the greater part is devoted to the effect of fur dust on the respiratory tract, not to mercurialism. Dust is said to be the great danger—a danger increased by mercury. The only other German article which I have found on mercurialism in the felt hat industry is a paper read by Heucke (23) before the Washington Congress of Hygiene in 1912. He gives no statistics as to the health of hatters' furriers or of hat makers, but says positively that these are dangerous trades and that the safeguards are inadequate. According to his description, the skins are often hung on racks and pushed for drying into heated rooms where burning coke furnishes the heat, and the carbon monoxide vapors, as well as those of mercury, are allowed to escape into nearby rooms. He speaks of the danger of nitrous fumes, especially in preparing the carrotting fluid, and says that all workers, from carrotters to the packers of finished hats, are exposed to mercury and that cases of poisoning occur, not only in fur cutting, but also in hat making. He found in hatters' fur only a small percentage of mercury, 0.3 to 0.7 per cent., but in sweepings and dust as much as 1.3 per cent.

Austria.—Teleky (4) of Vienna described the slow chronic form of poisoning found in hatters, as contrasted with the more rapid form which develops in other mercury-using industries where the exposure is more intense. It is evident from his description that the trade is not nearly so harmful in Austria as in some other countries. He examined the workers in two large factories. The first, an excellent place, employed 2,400 men and women, and there he found twelve persons with symptoms of mercurialism while four others were at the time incapacitated from the same cause, making one in 150 employed. The second factory was distinctly less well managed and there, among 500 to 600 employed, he found seven at work with symptoms of poisoning, or about one in eighty. The larger of these factories, Hückel's Söhne of Neutitschein, I had the opportunity of visiting in the summer of 1921, and found it admirable in construction and in management. Teleky's analysis of blown fur showed the presence of 2.338 per cent. of mercury

Italy.—In Italy, the centers of the hat industry are in the north and, although there are many cities in which such work is done, mercurialism is not at all notorious; in fact, little is known about it. Monti (3) investigated the industry and published his findings in 1909. He complains that in order to convince the manufacturers of the reality of this danger he was obliged to demonstrate the presence of mercury in the urine of some of the workers. He examined twelve carrotters, only three of whom were free from all lesions, even of the teeth. Seven of the twelve, employed from three to eight years, had bad teeth and complained of dyspepsia and of dryness of the mouth, with occasional attacks of salivation. The eleventh was much emaciated and the twelfth showed marked emaciation and typical tremor. He also found two out of five hardeners

with typical chronic poisoning of pronounced degree and three of slighter degree. Fifty sizers were also examined; thirty-five had marked mercurialism, nine a slight form, and only six were negative.

This is apparently the only report on mercurialism in hatters in Italian literature, and the subject is not even mentioned in Pieraccini's textbook. The trade is not notoriously unhealthful in Italy, partly, perhaps, because much of the fur cutting for Italian manufacture is done in Belgium, partly because conditions in the larger plants, at least, are excellent. The famous Borsalino factory in Alessandria, employing about 2,000 persons, and Valera and Ricci's in Monza, employing 1,200, are striking instances of what can be done to render work in this industry, not only safe, but comfortable, as I had an opportunity to see in the summer of 1921. There are certain features in the Borsalino factory which are superior to anything I have seen in this industry in any country.

Russia.—In 1909, Levitsky (24), a Russian, wrote an article for the *Revue d'hygiène* of Paris, describing a mission upon which he was sent by the Moscow Zemstvo to inquire into conditions in the felt hat industry in other European countries and to obtain suggestions, if possible, for a non-poisonous substitute for mercurial carrot, which the Russians were convinced was the source of much industrial poisoning. Levitsky gives no facts as to the industry in Russia prior to his journey, which was made in 1902, but says that the Zemstvo wished to discover a radical remedy for the terrible industrial disease of hatters—mercurial poisoning. "The question of suppressing the use of mercury in this industry is a question of delivering several hundred thousands of men and women from the suffering caused by chronic mercurialism, from invalidism, and premature death." Levitsky took back specimens of fur carrotted by the Jourde-Lussigny formula (sodium hydroxide and potassium hydroxide, followed by nitric acid and carbon), and the Zemstvo of Moscow induced one of the co-operative factories to work it up into felt. This was done with such success that two more factories undertook to carrot by this method altogether, the Zemstvo guaranteeing them against loss for four years. The hat makers of St. Petersburg, Moscow, and Warsaw declared the felt satisfactory and other co-operatives adopted the no-mercury process, so that in 1909 Levitsky was able to write that sixty-seven plants, employing 1,500 workers, were using the non-mercurial formula, and he was hopeful that mercurial carrot would be altogether done away with in Russian factories.

United States.—The first mention of the manufacture of felt hats in the United States was in 1662, when the Virginia Assembly offered a reward of 10 pounds of tobacco for every good felt hat produced from the fur of native animals. The importation of felt, of hatters' fur, and of finished hats has always been carried on very extensively, but for the last few decades the United States has also exported these hats. The industry falls into three divisions in the United States: fur cutting, "making," and finishing. Sometimes a plant that cuts fur also "makes" the hat, and the so-called hat factory may simply finish the bodies supplied by the "make shops." Other factories, but a minority, carry on all the processes from the raw skin to the finished hat. Philadelphia, Orange, Newark, New York City, Brooklyn, Yonkers, and Danbury and Bethel, Conn., are the principal hat manufacturing cities.

The earliest study of mercurial poisoning in the making of hats was made

by J. Addison Freeman, M.D. (25), of Orange, N. J., and was published in the *Transactions of the Medical Society of New Jersey* for 1859. This author reports that during the winter of 1858-1859 and the following spring there prevailed among the hatters of that region a disease showing all the characteristics of mercurial poisoning, swelling and ulceration of the gums, loosening of the teeth, fetid breath, abnormal flow of saliva, and shaking palsy of the upper limbs. More than a hundred cases occurred in Orange alone.

The next report is twenty years later, from the same city, Orange. In 1878, L. Dennis, M.D. (26), published a paper in the *Annual Report of the New Jersey Board of Health* on "Hatting as Affecting the Health of Operatives." The report is admirably complete and deserves far more attention than it has ever received. Conditions in the industry at that time seem to have been very bad, partly because of the use of very strongly carrotted shoddy. In some instances "all hands in the shop within a few days were rendered unfit for work or had their health impaired." Dennis gives the records of 1,546 men, with an average age of 32 years and average employment of twelve years. One hundred and two had a history of tremor in the past; fourteen had tremor at the time. Fifty-six had a history of sore mouth; twenty had it at the time. The incidence of these symptoms was highest in hardeners, next in finishers. Out of 168 cases of mercurialism which could be traced to their source in the factory, 107, or 63 per cent., were in finishing, and among 438 finishers then at work, eighty had mercurialism. Dennis insists that the finishing benches should be furnished with exhausts, as are the pouncing benches but there are obviously practical difficulties in the way. Among 39 blowers, 74 coners and wetters, and 39 hardeners he found respectively 8, 14, and 25 cases of sore mouth and tremor. Curiously enough, only two out of 450 cases of mercurialism were in sizers.

Much less valuable are two short papers, written in 1887 for the Board of Health of Connecticut by A. L. Scott and S. W. Williston. The different processes in the industry are described, but a very optimistic view is held by Scott as to the unhealthfulness of the trade; indeed, he refuses to believe that mercurial poisoning really occurs in Danbury, and holds that the cases thus diagnosed should be attributed to malaria. Williston says that there is quite a little mercurial poisoning, especially in forming, and that soft felt hats are worse than hard felt hats because they need much more finishing with pressing irons, and therefore more mercury is volatilized.

Philadelphia has long been one of the important centers for the manufacture of hats, including the preparation of the fur. The only report from that city that I have been able to discover is one written by L. H. Adler (6) in 1891. He describes five cases of severe mercurialism in hatters and, judging from their histories, the exposure to mercury must have been much greater then than it is at present, for it is very unusual to find so short an exposure resulting in such severe lesions. A boy of 14 was poisoned after a year's employment sweeping and feeding fur into cutting machines, but his loss of health began as early as the second month of his employment. A young man of 19 years, at the end of two and a half years' employment (which means that he began work at $16\frac{1}{2}$ years), was obliged to give up because of ataxia and jerking movements like those of major chorea. His gait was unsteady, his hands shaking, his tongue

tremulous, gums sore and swollen, breath fetid, and his memory impaired. The three others were men of 36 to 63 years of age and had worked only eight, nine, and ten years. When Adler saw them, they were suffering from salivation and gingivitis and palsies so severe as to incapacitate them. Number 3 was 35 years old, had been a hatter for ten years, had lost flesh from year to year and suffered from frequent attacks of indigestion and constipation. At the end of eight years tremors began, in the hands at first, then spreading all over the body and accompanied by muscular twitchings but no impairment of sensation. The tongue was affected and his speech was hardly intelligible; he had much difficulty in going down stairs, and suffered from terrifying dreams. After quitting work for several months and taking salt baths, he was somewhat improved but remained ataxic and tremulous, with marked blurring of the vision, tremors of the tongue, thick speech, fetid breath, spongy gums and loosened teeth.

In 1911, the New York Labor Department in its annual report included a section on the felt hat industry in New York State, written by C. T. Graham-Rogers and Charles Vogt (27). Apparently, at that time there were various harmful features in the industry which are not found now in well-constructed modern factories, such as exposure to the dust from cutting machines which had no exhaust, and to dust from pouncing. Many boys and girls were said to be employed. In one shop, 2.6 mg. of mercury were found in 1 cubic meter of air.

A very interesting study of mercurial poisoning was made by Mrs. Linden Bates (11) for the Women's Welfare Department of the National Civic Federation and issued by them in monograph form in 1912. This report comprises an analysis of 102 cases of industrial mercurialism occurring in New York City and its vicinity. Most of these cases had had their origin in the felt hat industry of Brooklyn, Yonkers, Newark, and Orange. Mrs. Bates had already made an investigation of the same industry in Great Britain. It was not possible for the investigators to study the physical condition of the men and women actually at work but they were able to discover a number of cases of mercurial poisoning which had come under the care of physicians, chiefly in hospitals and clinics. Their conclusions are made conservatively and no cases listed without the diagnosis of a physician. They found that mercurial poisoning was notorious, especially, so it was said, among the men using imported skins which were already carrotted. Whatever the reason, it was universally believed that foreign carrotted pelts were much worse than those prepared in this country. In plants doing their own carrotting, the solution was made by mixing four carboys of nitric acid, 75 pounds of mercury and 50 of water. Sometimes a mixture of silver nitrate, corrosive sublimate, and arsenious acid was added to this.

Carrotting was generally held to cause acid fume poisoning but not mercurialism. However, the investigators found a carrotter in the hospital who had been under treatment for six months for mercurialism. He had been obliged to stop work on account of sickness seven times in fourteen years, and at the time was suffering from anemia and tremors of the limbs so severe that he could not stand. Drying did not seem to be attended with as much trouble in American factories as in the British. Brushing was usually fairly well carried on, but cutting and sorting were quite

bad. Eight cutters were found suffering from chronic poisoning, seven of them with blackened and eroded teeth and marked tremor which, in the case of three, incapacitated them for work. There was also found to be a good deal of trouble among formers and hardeners and sizers. Of thirty-one cases of chronic mercurialism studied, thirteen came from forming, five from hardening, and thirteen from sizing.

In all, eighty cases of chronic mercurial poisoning were found, and their histories are given as much in detail as possible. With regard to twenty-one, only the diagnosis could be obtained, but the histories of the other fifty-nine show that tremors were present in forty and localized paralysis in four, multiple neuritis in five. In fourteen there were psychic disturbances, insomnia, headache, depression, even melancholia, impaired memory, hallucinations, and, in five cases, suicidal tendency. It is interesting to note that salivation is mentioned only once.

As many of these men were the wreckage of the industry, it is to be expected that their condition would sometimes be very serious but none of the foreign studies of mercurialism in this trade give so extreme a picture of physical degeneration as do this report and the one of Adler's already quoted.

Finally, there is an investigation made by Louis I. Harris, M.D. (9), Chief of the Division of Industrial Hygiene of the New York City Health Department, which covers the hatters' fur industry and the manufacture of felt hats in that city. Dr. Harris examined 266 persons engaged in the preparation of hatters' fur, 110 of them being women. They were for the most part Italians and Poles of a poor social grade, and, according to their own statement, fifty-one of the women and 118 of the men drank alcohol regularly. Only seventeen of the whole number were found to be free from physical defects. Dr. Harris endeavors to be very cautious as to the amount of mercurialism present, but he found ninety-one cases of either very marked or moderate tremor of the arms, face, and tongue. He also found eighty-three with marked inflammatory or spongy condition of the gums. Seventy of the seventy-seven carrotters and cutters had black teeth, and seventeen had signs of advanced arteriosclerosis. He succeeded in obtaining thirty-three specimens of urine for examination, and sixteen were positive for albumin.

The evidence of mercurialism among hat makers was less striking than among hatters' furriers. Only eighty-one persons could be examined, all but twelve of them men. Seven had marked tremor, seven more moderate, and eleven slight. Harris does not accept these last as clear cases of mercurialism. Anemia was present in twelve of the sixty-nine men, and marked gingivitis in three.

His summing up of the two industries together is as follows: Among nearly 350 employees, forty-seven, or nearly 14 per cent., had distinct gingivitis, together with marked or violent tremors of the hands, face, and tongue; another 14 per cent. had moderate tremor with gingivitis, accompanied in a number of instances by anemia and arteriosclerosis.

The rate of poisoning, especially among the furriers, is very high compared with that reported in recent years from Great Britain, and compared with the rates found by Teleky in a similar study in Austria.

Prevalence of Other Occupational Diseases among Hatters

Loss of weight, pallor and loss of strength are, according to some observ-

ers, almost universal among hatters. Thus Schütte describes the women in this industry in Germany as thin, narrow-chested, stoop-shouldered, with pale, emaciated faces, dull eyes, shallow breathing, complaining of headache, general weakness, frequent nosebleed, and menstrual disturbances. Several French writers, Espanet, Jungfleisch, and Martial, speak of the industry as extraordinarily unhealthful, causing many deaths each year. Schoull says that hatters suffer from profound anemia, and Levitsky believes that invalidism and premature death are common among Russian hatters. On the other hand, Glibert finds that women in the Belgian fur cutting trade do not compare unfavorably with those employed in other low-wage industries, such as the linen mill operatives. There seems to be a general impression that women fur cutters and hatters suffer from scanty menstruation and are more likely to abort than are the majority of working women, and that the mortality rate among their children is higher. But Glibert found that in this respect the linen mill operatives were rather worse off than the women hatters, at least so far as the death rate of their children is concerned.

It is, however, with regard to the prevalence of respiratory disease that the greatest difference of opinion is found. The most sweeping statement as to the injury done to the respiratory tract by fur dust quite irrespective of the mercury is made by Schütte, who calls this the most harmful feature of the hatters' environment. He describes the various "dust inhalation diseases from animal dust" as: nasal catarrh, not of the usual kind but purulent and offensive; ozena, caused by putrefaction of the hair dust in the nostrils and followed by atrophic rhinitis; catarrh of the throat from the mouth breathing, necessitated by the clogged nostrils; chronic laryngeal catarrh, often purulent, and followed by erosions and ulcers of the vocal cords; chronic bronchial catarrh with emphysema. It is also assumed by the French that fur dust is in itself injurious, although they believe that by far the greater danger faced by the hatters is mercurialism. Among the English, Taylor thinks phthisis is frequently the cause of death in hatters, mercurialism rarely; while Tylecote says that there is not sufficient ground for the belief that the prevalence of phthisis is higher than the average in this trade except among blowers and finishers. In those groups which show the greatest incidence of mercurialism —formers, plankers (sizers), pressers, and stovers (dryers) — he saw no increase of respiratory disease.

The only real attempt to differentiate between the effect of mercury-free dust and carrotted dust was made by Glibert in the Belgian factories. The work of preparing the skins for carrotting is largely a home industry in Belgium. It is very filthy work and to the ordinary visitor it seems to be most unhealthful. The raw skins, with bits of flesh and dried blood and all sorts of dirt adhering to them, must be cut open by hand and trimmed, and then the coarse hairs plucked out and the skins brushed. At the Brussels Exposition, in 1910, I saw some faithful reproductions of peasant huts and tenements in which this process of *éjarrage* was being carried on, and certainly it was a disgusting sight, offensive to eyes and nose. Glibert, who has been familiar with this trade since 1892, assures us, however, that it is filthy but not unhealthful. He superintended a thorough physical examination of the workers made by the state physicians, who could find little more than a

slight irritation of the nasal mucosa, sometimes conjunctivitis, sometimes otitis externa, but no occupational disease. He believes that the long, flexible hairs do not reach the lungs but are caught in the upper air passages and expectorated. His statistics show that among the men working with non-carrotted fur 91.9 per cent. were in good health, but only 77.3 per cent. of those working with carrotted fur and 63.6 per cent. of the carrotters.

In 1886 J. W. Stickler, M.D. (28), of Orange, N. J., published a paper on "Hatters' Consumption." His studies were made in hat factories, not fur-cutting plants. He found that those engaged in the felting processes and in pouncing suffered commonly not only from tremor but from catarrh and rheumatism and pulmonary disease. Fifty-three per cent. of the deaths among hatters in the Newark-Orange district from 1873 to 1886 were from pulmonary phthisis. He collected 772 records of deaths among hatters in the Orange valley, in Connecticut, and in Philadelphia, 375 of whom, or 51.8 per cent. had died of phthisis. The other occupational diseases, tremor, rheumatism, and catarrh, were found distributed as follows:

Occupation	Catarrh	Rheumatism	Cough	Tremor or History of Tremor
240 sizers	76 (31.6%)	44 (18%)	41 (17%)	30 (12.5%)
27 pouncers	12 (44.4%)		4 (15%)	5 (18.5%)
222 finishers[1]	64 (28.8%)	15 (6.7%)	42 (18.9%)	33 (14.8%)

[1] There were also 18 with sore mouth or history of sore mouth; 7 with bronchitis; 4 with phthisis; and 1 with asthma.

Stickler says that mixers and blowers suffer chiefly from catarrh and rheumatism, that coners, hardeners, and blockers add tremor to these two; sizers have these same and also pulmonary affections; pouncers suffer from pulmonary affections and tremor, finishers from all of the above affections.

The investigators for the National Civic Federation found in the hatting centers of northeastern New Jersey a general consensus of opinion as to the prevalence of tuberculosis, especially among the finishers and pouncers. Selskar Gunn, Health Officer of Newark, in 1908 wrote of "the extreme prevalence of tuberculosis among hatters." In an effort to decide the degree of health hazard to which hatters are exposed, Frederick Hoffman, Statistician for the Prudential Life Insurance Company, compared the mortality in this trade with that in the tailoring trade which is accepted by insurance companies at ordinary rates, although there are injurious features connected with it, such as sedentary indoor work. He finds that hatters have a higher mortality than tailors at all ages, but especially in the thirty years between 35 and 65, during which period the excess is 4.1 for the first decennium, 7.2 for the second, and 23.4 for the third. The following statistics were presented by this company at the International Congress for Tuberculosis in Washington, 1908, demonstrating the proportion of deaths from tuberculosis to deaths from all causes between 1897 and 1906:

Percentage of Deaths from Tuberculosis among

Ages	All Males in United States	832 Hatters
15-24	27.8	53.8
25-34	31.3	55.4
35-44	23.6	45.4
45-54	15.0	26.7
55-64	8.1	11.8
65 and over	2.7	0.8

How hopeless it is to look for accurate information on this point in the vital statistics of American cities is shown in the figures collected by Hoffman. In 1886 to 1890, the proportion of deaths from tuberculosis to deaths from all causes amounted among Philadelphia hatters to only 25.3 per cent., but among

Brooklyn hatters to 39.1. In 1890 among the hatters of Connecticut, only 29.1 per cent. of the deaths were caused by tuberculosis, but among those of New Jersey 37.3 per cent. were due to this cause. In Danbury I was assured by the men in the industry that a search through the vital statistics of that city would be useless trouble, for it was well known that, if a man died of tuberculosis within a few years of taking out insurance, the family insisted on having the death certificate made out for some other disease in order to avoid difficulties with the insurance companies. Nevertheless, the figures from Danbury, when compared with those from cities in Connecticut of about the same size, and with those from the whole state of Connecticut, do show a higher mortality rate and a higher proportion of deaths from tuberculosis. The following statement has just been secured from the Connecticut Department of Health for the year 1921.

	Population	Death Rate per 1,000 Population	Death Rate from Tuberculosis per 1,000
Danbury	22,325	15.2	1.21
Greenwich ..	22,997	11.5	0.61
Torrington ..	22,860	8.0	0.48
Whole state	1,420,576	11.4	0.96

John T. Black, M.D., Commissioner of Health, writes that the town nearest in size to Danbury is Middletown, but that the State Hospital for the Insane is located there and therefore the data for this town are not comparable with those for Danbury. Greenwich, situated at sea level, has, as its principal industries, agriculture and the manufacture of woolens, tinners' hardware, iron and belting. Torrington, in a hilly district, is a manufacturing city, the principal industries being the manufacture of sheet and rolled brass, copper and spelter castings, nickel, silver and [illegible] plated goods, needles, machines, upholstery, and woolen goods. One would expect to find the rate of tuberculosis in Torrington at least as high as in Danbury.

Summary

Industrial mercurialism as seen in hatters is slow in onset and course, and lacks some of the characteristics of more rapidly developing forms of this intoxication. Salivation is rare, but gingivitis is fairly common, especially at the beginning. Carrotters suffer more than others from blackening and erosion of the teeth. Tremor is the most typical symptom; erethism is not common; and there are no characteristic findings in the gastro-intestinal tract, the skin, the urine or the blood.

Statistical data from the different countries of Europe show a much higher rate of mercurialism among fur cutters and hatters in Belgium, France and Italy than in England and Austria. Recent studies made in New York City and northeastern New Jersey revealed a great deal of mercurialism in these trades and many instances of the severer forms, especially in fur-cutting shops.

The emery dust produced in finishing (pouncing) is excessively fine silicious dust, and constitutes an occupational hazard that is beyond dispute, but the question of the harmfulness of the animal dust produced in various departments of fur cutting and hat making is in a state of great confusion and cannot be settled without a much more thorough examination of the men and women employed in these processes than has been made so far.

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THE IDEAL WORK-CURVE*

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OBSERVATIONS upon output have been relied upon in a large number of studies directed toward the investigation of industrial fatigue; observers have based their estimates of the physiological results of human activity upon the fluctuations of hourly or daily work-curves. Study of these work-curves points to the probable existence of an ideal work-curve; and, further, it indicates that, should such an ideal curve exist, it would be a straight line showing a slight steady rise from hour to hour and from day to day. Evidence is presented in this article in favor of this proposition, which is of considerable importance in industrial work. Such a curve would indicate that, at the beginning of the day or week, the operative concerned started work very nearly at a maximum rate, and that, as time progressed, practice gradually increased his working capacity; it would demonstrate the existence of a fine adjustment of the operative's working powers to his task with a consequent elimination of undue fatigue. It would render possible, by intensive study of industrial operations, the adjustment of methods, hours, and conditions of work in order to enable this steady maximum of output to be achieved.

The realm of sport affords many examples of the ideal work-curve. The long-distance runner ascertains exactly what is the greatest pace he can maintain lap after lap, and by long training he accustoms himself to this pace. Training for other forms of sport is similar. The chief point is to insure a constant attainment of maximum effort over the whole period of the contest. There must be no spurting in the early part of the race; if the athlete has an extra ounce of energy he must save it for a final spurt. So must it be in industrial work, if the best results are to be obtained.

CURVES DRAWN FROM MASSED DATA

Examination of several typical work-curves for industrial operations discloses support for this contention; Collis and Greenwood (1) have adduced curves

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which are of interest. Figure 1A shows a rapid fall from the first hour of each spell of work. This curve represents heavy, monotonous work: the task entailed hard physical exertion unrelieved by any variety of processes. Another curve for a monotonous operation, this one involving no strenuous exertion, is

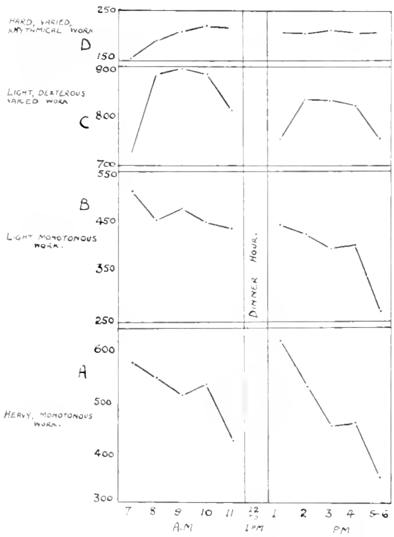

FIG. 1.—Showing typical work-curves in industry.

shown in Figure 1B. Here again we find the steady fall in output, but as the physical work is lighter the fatigue is not so marked. Figure 1C represents work which is light and dexterous, and not monotonous. Here the onset of fatigue is postponed until later in the spell, and the fall in output is not nearly so marked. Figure 1D represents hard, varied, rhythmical work. Although the work was heavy, variety was introduced, and the rhythmic nature of the operation militated against the onset of fatigue, just as is the case in dancing. When variety and rhythm are present we approach our ideal curve.

Another diagram relating to large numbers of workers is reproduced from Vernon's report on British munition factories (2). (See Fig. 2.) The top curve (D) relates to men working fifty-three hours a week at turning and boring 3-inch shells. The work was comparatively light, and the hours not very long, with the result that the work-curve shows a steady rise to Friday. In the remaining curves the work was heavier (when it is considered that, for

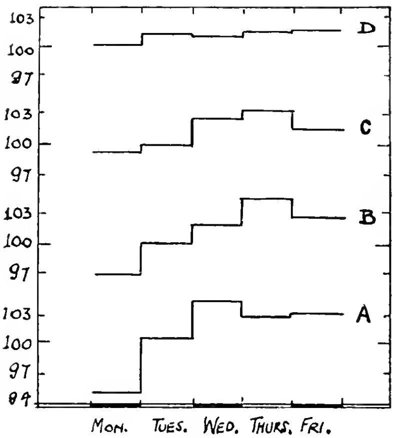

FIG. 2.—Showing comparative work-curves of workers in various factories. A=curve for 140 women working 57.4 hours a week at cartridge-case (rifle) operations; B=curve for 1,000 women working $58\frac{1}{2}$ hours a week at lathe operations, and stamping fuse parts; C=curve for 1,000 men and 300 women working $58\frac{1}{2}$ hours a week at lathe operations, presses for 18-pound cartridge cases, etc.; D=curve for eighty-one men working 53 hours a week at turning and boring 3-inch shells.

the most part, women were concerned), and the hours longer. These curves show a steep rise in the early part of the week and a falling off from Wednesday or Thursday. Apparently the week-end rest did not suffice for full recuperation from fatigue, but practice caused a rise

in output. As the week progressed fatigue overcame the effects of practice, and output fell.

The report on an investigation into the effect of hours of work, carried on under F. S. Lee (3), lends further support to the contention. One diagram, Figure 3, will suffice as illustration. This diagram shows the comparative maintenance of output at two factories, one an eight-hour plant and the other a ten-hour plant. The curve of the eight-hour plant shows a much closer approximation to maximum output than does that of the ten-hour plant, and the ratio of the output in the second spell to that in the first is much higher in the plant where the shorter hours were worked.

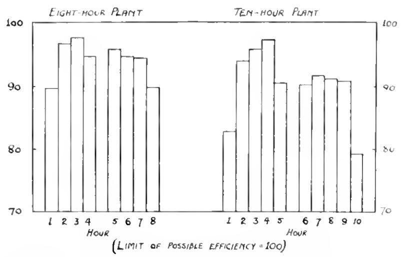

FIG. 3.—Showing comparative outputs of an eight-hour plant and a ten-hour plant.

The foregoing examples show that with greater variety and shorter hours of work there is closer approximation to our ideal curve. These curves, however, do not show the output of single operatives; they refer for the most part to large groups of workers, and in massing data in this way the individual is lost sight of. Grouping tends to smooth out irregularities, and for this reason a study of the output of individual operatives will serve our purpose better than a prolonged examination of figures concerning whole factories or whole departments.

OUTPUT OF INDIVIDUAL OPERATIVES

Previous Observations.—In an investigation in boot and shoe factories, Loveday and Munro (4) found that:

> Where two or more records of output are available for the same operation, the more highly-skilled operative has a more regular graph, and shows less inclination to fall off towards the end of the week than the operative with a lower average output. This phenomenon occurs so frequently that a very irregular graph or serious falling off beginning early in the week will in the very great majority of cases be found to coincide with a low output. Where a workman is comparatively unskilled or ill-suited to his job, his output curve tends to be irregular or to drop as the week passes, whereas the skilled operative, employed on congenial work, shows a curve approaching more nearly to the ideal of a rise throughout the week.

In their report, Loveday and Munro give many diagrams in support of this statement. It will be sufficient for our present purpose to reproduce the first of these charts (Fig. 4), which shows the

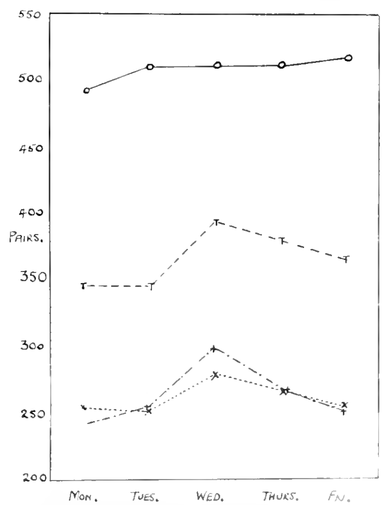

FIG. 4.—Showing actual average daily output of four bottom scourers.

average work-curves of four bottom scourers. The curve of the most highly skilled workman shows a rise throughout the week, while the curves of the other three men reach their highest point on Wednesday and then fall rapidly away. The poorest man of the group shows a slight dip from Monday to Tuesday.

New Observations.—Since the publication of the report by Loveday and Munro, the writer, working for the Industrial Fatigue Research Board, has examined the daily records of output from other boot and shoe factories. These records confirm, to a remarkable extent, the findings of Loveday and Munro; and as the data are hitherto unpublished they are dealt with more fully. In each case the output over a period of twenty to twenty-four weeks was considered. Records for Saturday, on account of the well-recognized influences which affect the output of this half-day, have been omitted; and in some cases, owing to peculiarities in the methods of "booking" work, the figures for Monday or Friday have had to be ignored. Table 1 gives the average output of operatives at Factory A, where the chief product was women's boots.

Heel Scouring.—While the best man reaches his maximum on Wednesday, and the other two on Thursday, the best man has only a slight fall from his maximum and remains almost steady from Thursday to Friday. Of the two men with maximum outputs on Thursday, the poorer man has a slight dip on Wednesday and a steep fall from Thursday to Friday, while the better man shows a rise in output to Thursday and a much slighter fall to Friday.

Heel Trimming.—Only one man's record was obtained. He is recognized as a highly-skilled worker—the best for his operation in the factory—and his output shows a Thursday maximum. The level of his output varies but very slightly, the mean variation of the daily averages being only 0.2 per cent. of his average output.

Bottom Scouring.—The better man has his maximum on Wednesday, the poorer man, on Thursday; but the better man's fall to Thursday is only 0.2 per cent., and his curve is more regular than that of the poorer man. The output of the latter falls much more steeply from Thursday to Friday.

Seat Wheeling.—The best man in this group reaches his maximum on Thursday, the second on Tuesday, and the third on Thursday. The fourth man, whose output is by far the lowest, shows practically a straight line curve. This last man is about 70 years of age, and his unusually regular curve is probably due to his having adopted some limitation of output as a measure of self-protection.

Edge Setting.—The best man has a definite maximum on Wednesday, the second on Tuesday, and the third on Monday. The fourth man's output reaches a maximum on Tuesday, but the rise from Monday to Tuesday is only slight. Monday is the best day for the fifth man. The sixth has a maximum on Wednesday, and then falls away. The seventh man has a very erratic curve; his output reaches a maximum on Tuesday.

Pulling Over.—All three men have a maximum on Wednesday. The worst man has the steepest fall from Wednesday to Thursday.

Consolidated Lasting.—These men reach their maximum on Wednesday, and their curves are practically the same. Men on this operation work as a team, hence the similarity in their outputs.

Knocking Up (Pounding Up).—The best of these three men has his highest output on Wednesday; the other two, on Tuesday. The best man has the most even output. Of the two worst men, the better recovers on Thursday, while the other continues to fall away.

Getting Off.—The first man has his best day on Thursday. Although the second man has his maximum on Monday he has almost the same output on Thursday; his curve is almost a straight line. The third man shows a steady rise to Thursday; the fourth falls from Wednesday to Thursday. The two best men have the straightest curves, while the curve of the worst man is the most erratic.

Averages of daily output for operatives at Factory B are given in Table 2. At this factory, Saturday's and Monday's outputs are grouped together in the company's books, hence the output from Tuesday to Friday only is considered.

Heel Scouring. — Both men have their highest output on Tuesday, but the better man recovers to a greater extent on Thursday than does the other man.

Edge Trimming.— In this operation both men reach their maximum on Wednesday. The better man has the more variable curve, but his greater variability is probably due to the fact that this man, though a highly-skilled worker, is in a poor state of health and is notably a bad timekeeper.

Getting Ready.—The best man of this group reaches his maximum on Friday, the second man on Thursday, and the third on Tuesday. The worst man reaches his acme on Thursday, but his output falls steeply from Tuesday to Wednesday, and more steeply from Thursday to Friday: his curve is very erratic.

TABLE 1.—SHOWING ACTUAL AVERAGE DAILY OUTPUT FOR OPERATIVES AT FACTORY A

Operation	Operatives in Order of Merit	Whole Period	Average Daily Output in Pairs for Monday	Tuesday	Wednesday	Thursday	Friday
Heel scouring	1	575.2	580.3	574.0	*582.2*	570.4	569.3
	2	512.6	511.2	508.9	515.2	*519.4*	508.3
	3	492.9	485.4	499.3	495.0	*501.9*	482.7
Heel trimming	1	934.2	933.7	932.7	934.9	*938.2*	931.4
Bottom scouring	1	636.9	627.0	645.1	*650.2*	649.0	613.1
	2	572.5	558.8	580.4	586.6	*596.7*	540.0
Seat wheeling	1	573.4	581.3	575.0	575.0	*586.3*	549.4
	2	543.8	529.7	*565.1*	542.6	543.3	538.3
	3	539.4	523.6	541.0	546.4	549.3	536.7
	4	380.9	374.7	383.4	383.3	379.3	*383.6*
Edge setting	1	181.7	179.1	182.5	*186.0*	181.3	179.6
	2	181.3	179.3	*183.9*	182.8	181.5	178.9
	3	177.1	*182.5*	178.5	175.1	177.4	172.0
	4	176.7	178.9	*179.6*	175.5	174.0	175.3
	5	175.7	*178.0*	176.3	174.9	175.4	174.1
	6	174.3	175.9	174.0	*176.8*	174.6	170.1
	7	173.5	173.9	*179.0*	170.6	175.9	168.0
Pulling over	1	444.3	435.2	447.3	*449.0*	445.8	—
	2	417.2	410.1	419.0	*421.1*	418.5	—
	3	382.5	379.4	380.7	*388.9*	380.9	—
Consolidated lasting	1	192.1	187.5	192.5	*195.4*	193.1	—
	2	191.6	187.2	193.3	*194.7*	192.1	—
	3	191.6	187.5	192.6	*193.4*	193.1	—
Knocking up (Pounding up)	1	678.2	667.6	667.8	*698.8*	668.5	—
	2	661.8	645.0	*676.9*	654.7	670.5	—
	3	635.7	621.8	*648.0*	643.1	630.0	—
Getting off	1	398.9	399.0	400.4	392.6	*403.7*	—
	2	370.8	*371.6*	369.4	370.7	371.4	—
	3	343.2	339.5	340.0	345.0	*348.2*	—
	4	215.6	213.4	211.8	*223.4*	213.7	—

Edge Setting.—Here the two best men have their maximum outputs on Wednesday. The better of these has the slighter fall from Wednesday, and his fall is checked on Friday; while the worse man shows a steep fall. The third man reaches his maximum on Thursday, and his curve is the steadiest. He is recognized as a steady worker who takes life easily, and it is practically certain that he does not work to his full capacity.

TABLE 2.—SHOWING ACTUAL AVERAGE DAILY OUTPUT FOR OPERATIVES AT FACTORY B

Operation	Operatives in Order of Merit	Whole Period[1]	Average Daily Output in Pairs for Tuesday	Wednesday	Thursday	Friday
Heel scouring	1	186.8	*192.1*	186.1	191.1	178.1
	2	125.6	*133.8*	125.0	126.8	116.8
Edge trimming	1	381.6	371.8	*409.2*	377.8	367.7
	2	266.9	257.7	*273.6*	268.1	268.3
Getting ready	1	156.7	155.7	155.2	157.0	*158.7*
	2	150.5	150.8	149.5	*151.3*	150.4
	3	119.5	*120.9*	119.6	118.0	119.4
	4	96.0	99.3	92.8	*100.0*	92.0
Edge setters	1	199.8	195.6	*209.2*	197.8	196.5
	2	189.3	190.6	*207.0*	191.7	167.8
	3	174.9	175.6	175.4	*178.7*	170.0

[1] It was impossible to secure the output for Monday owing to the fact that Monday's and Saturday's outputs were grouped together in the company's records.

Distribution of Output

The figures just examined show the average values for each day of the week. They show clearly that in almost every case the best workman has the most regular average curve, and that this curve approaches most nearly to the ideal of a steady rise throughout the week. The question arises whether the most skilled man is actually the most consistent worker if, instead of averages, the output of individual days is taken. This point may be tested by arranging each man's record in the form of a frequency distribution. Generally the best worker is found to have his output values more closely grouped about the mode (or most usual figure) than have his fellow-workmen. The frequency polygons shown in Figures 5 to 10 illustrate this point. Not all the men's records are illustrated in this way, but with only one or two exceptions this phenomenon holds good.

It seems, then, that whether we consider the average daily values or the

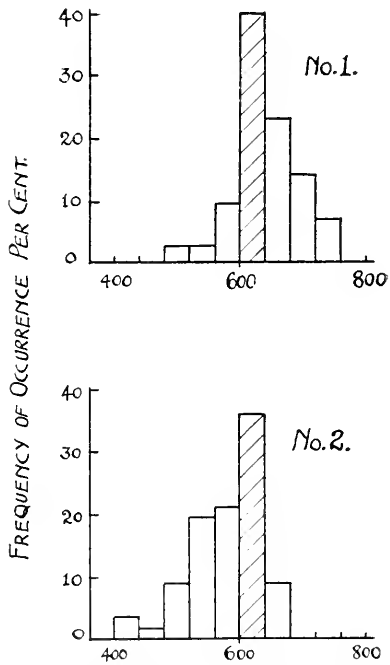

FIG. 5.—Showing output, in pairs, of two bottom scourers at Factory A.

frequency distributions of output, we find that the unskilled worker is more erratic than his more highly-skilled workmate.

Another interesting point is brought out in the frequency polygons shown in Figures 5 to 10. In several instances men on the same operation show similar modal values, but the better man has more observations falling above the mode, and fewer below it, than has the poorer man. Figures 5 and 6 clearly illustrate this point in the case of bottom

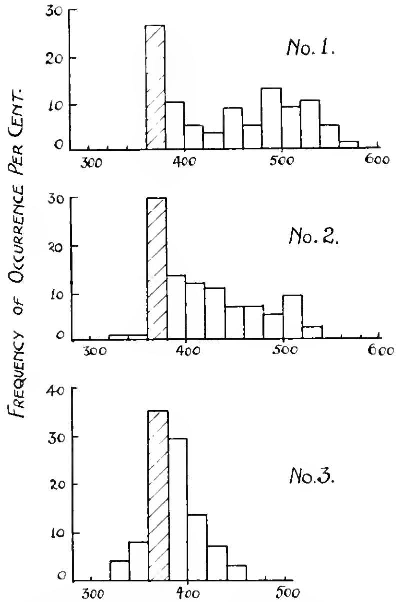

Fig. 6.—Showing output, in pairs, of three pullers over at Factory A.

scourers and pullers over at Factory A. In the group of four getters off (Fig. 7) it is again noticeable. Operative No. 1 does not entirely agree, but the other three men of the group show a markedly frequent occurrence of output of from 320 to 340 pairs a day. Operative No. 4, whose output level is very low, has a noticeable frequency at this figure. At Factory B the three edge setters (Fig. 8) show a well-defined frequency of output of from 190 to 200 pairs per day, and the best man has an output of over 200 more frequently than the others. There is a very considerable difference between the efficiencies of the two heel scourers at Factory B; the better man averages three pairs to the other man's two pairs, yet their frequency distributions (Fig.

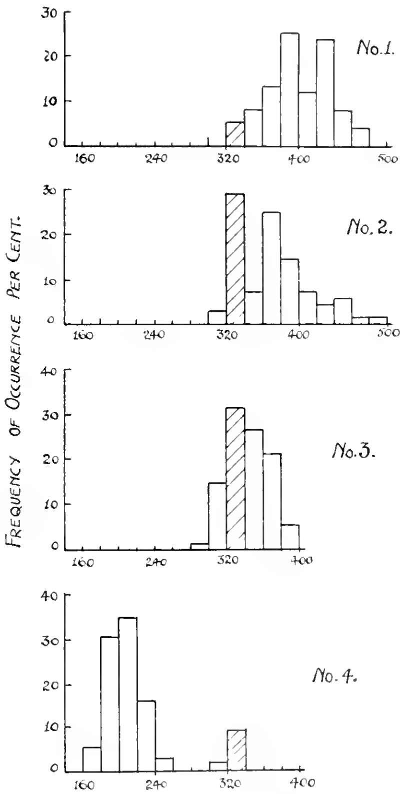

Fig. 7.—Showing output, in pairs, of four getters off at Factory A.

9) show a tendency toward an output of about 150 pairs. A somewhat similar diagram is shown in the case of the two edge trimmers.

At both factories payment is by a supplementary piece rate, that is, any output above the standard for the operation is paid for at a uniform piece rate. The similar modes in the frequency distributions, therefore, are clearly not due to the operation of any premium bonus. There appears to be some understanding as to what constitutes a good day's work, and the highly-skilled worker often exceeds this figure, and rarely falls below it. On the other hand, the operative whose skill is less strives to attain this figure and fails to reach it more often than he exceeds it. This constant effort on the part of the less-skilled worker may account for the earlier decline of his average weekly curve.

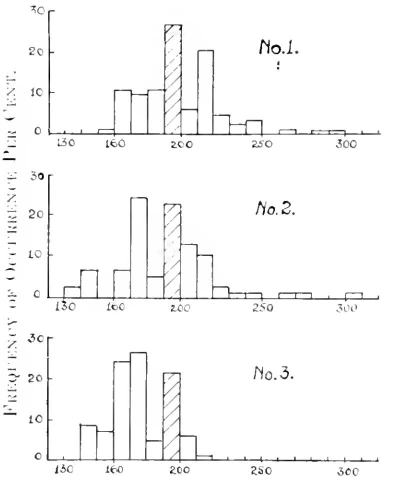

FIG. 8.—Showing output, in pairs, of three edge setters at Factory B.

OTHER EXAMPLES OF OUTPUT

An interesting example is afforded in a report on "Motion Study in Metal Polishing" by Farmer and Brooke (5). Certain girls were employed "roughing" spoons, an operation which required them to stand at their machines all day. The process of glazing was introduced to assist the "roughers," and at this operation the girls were enabled to sit. The output of one girl is given in Tables 3 and 4. Observations were made continuously for two days. On the first day the girl was engaged in roughing tablespoons without glazing, and on the second day she glazed the edges of the spoons before roughing them. The tables give the actual time taken; all unproductive time, such as that taken for rests or for getting fresh work, is omitted.

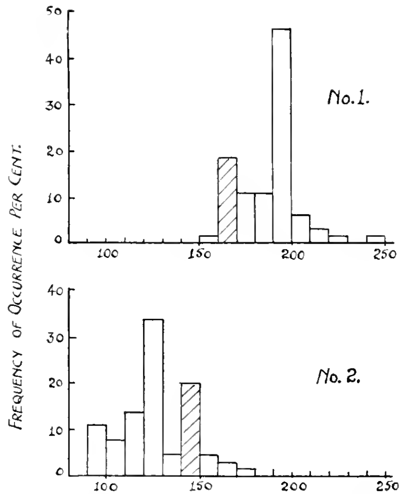

FIG. 9.—Showing output, in pairs, of two heel scourers at Factory B.

On the second day when the edges were glazed the girl's output was actually increased by eight spoons. On the first day she took twenty minutes longer to rough the last three dozen spoons than to rough the first three dozen; but on the second day her time for roughing was only eight minutes longer at night than in the morning. The investigators concluded that "there is

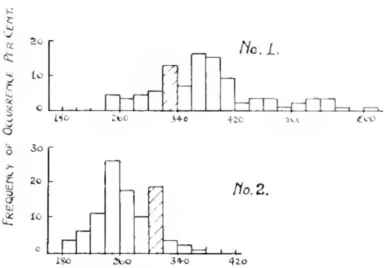

FIG. 10.—Showing output, in pairs, of two edge trimmers at Factory B.

a strong probability that the introduction of glazing diminishes the fatigue of the worker by enabling her to sit at her work for certain periods during the day." This diminution of fatigue is accompanied by a nearer approximation of the work-curve to the ideal, as will be seen from a comparison of the roughing times in Tables 3 and 4.

Another instance may be quoted from the same report. The output of an "outside grease dollier" was ascertained when she worked standing and when a comfortable seat was provided. In this case the investigators found that:

1. The output when the worker is seated is higher than when she is standing. Thus the average half-hourly output throughout the day is 18.1 units when sitting and 16.3 units when standing.
2. Although the fluctuations in her output curve when she is seated are greater than when she is standing, yet there seems to be more buoyancy in the former case. Thus in the morning the curve representing work sitting constantly reaches the standard of the first hour's work, and although it drops below it in the afternoon, yet it exceeds it in one spurt at 4 o'clock. On the other hand, the curve representing work standing, except for two spurts at 12 o'clock and 4 o'clock, never touches the standard reached during the first hour's work of the morning.

TABLE 3.—OUTPUT OF WORKER 15

(Roughing Only)

Spoons	Rate of Work (Minutes per 3 Dozen)	Hour Completed
First 3 dozen..........	100½	10.17 A.M.
Second 3 dozen........	119½	2.03 P.M.
Third 3 dozen..........	98½	4.19 P.M.
Last 16	126½	5.25 P.M.
124	Av. 108	

TABLE 4.—OUTPUT OF WORKER 15

(Glazing and Roughing)

Spoons	Rate of Work (Minutes per 3 Dozen) Glazing	Roughing	Total	Hour Completed
First 20....	32½	77½	110	9.17 A.M.
First 3 dozen	20	80	100	11.31 A.M.
Second 3 doz.	29	77	106	2.43 P.M.
Third 3 doz.	33	85½	118½	5.09½ P.M.
Last 4	—	—	—	—
132	Av. 28	Av. 80½	Av. 108½	

An investigation now being carried on by Dr. H. M. Vernon and the writer is affording somewhat similar results. The output of a group of girls engaged in labelling small packets shows that, on the whole, the quickest workers approach most nearly to a rise throughout the day. The slowest workers show a greater fall in output as the day progresses.

No reference has so far been made to the influence which social habits may exert on the work-curve; one influence must, however, be noted—namely, the

use of alcohol. Stehr (6) has pointed out that the more a workman indulges in immoderate use of alcohol during the week-end, the more his work-curve shows a steady upward direction in the course of the week. This result Stehr ascribes to the disappearance of intoxication. Although the curve of such a workman tends to rise as the week advances, yet it rises much more steeply than does the ideal curve; this phenomenon is shown graphically in Figure 11

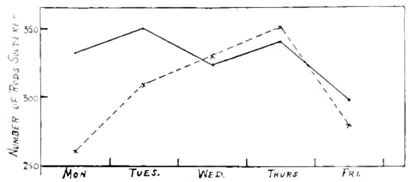

Fig. 11.—Showing comparative work-curves of two solderers in a Cologne umbrella factory. Unbroken line=steady man; broken line=man easily persuaded to drink.

drawn from records given by Stehr. The records upon which it is based are averaged on the output of four weeks at the monotonous process of soldering iron rods over a coal fire—work which required no particular intelligence or manual dexterity. There should generally be no difficulty in distinguishing the steeply rising work-curve of a week-end drinker from the gentle ascent of the ideal work-curve.

Summary

Examples have been given which show that:

1. Where there was a variety of work and the operation was of a rhythmic nature, a rapid fall in output was avoided and the work-curve remained steady with a tendency to rise throughout the day.

2. When the hours of work were shorter and work lighter, the output rose throughout the week; while with longer hours and heavier work the output curves were increasingly irregular with a rapid falling off toward the week-end.

3. At a factory with an eight-hour day there was a closer approximation to an even maximum output than at a factory with a ten-hour day.

4. Individual output records show that in boot and shoe factories, in practically every group of workers considered, the best worker of a group had a graph rising toward the end of the week, while the poorer workman's curve fell earlier in the week and was more irregular. Consideration of frequency distributions reveals the fact that the better worker was consistently steadier than his fellow-workmen.

5. In a group of girls labelling small packets, the quickest worker was generally the steadiest.

6. Other examples show that where fatigue was lessened by the provision of sitting accommodation, output was higher, and the work-curve came nearer to our ideal of a rise throughout the day.

Conclusion

While each of these examples in itself may be of little significance, each lends support to the others. Especially remarkable are the hitherto unpublished boot and shoe data: in almost every group of workers the same connection between efficiency and steadiness was found. The work-curves of the best workers and of those employed under the best conditions almost invariably tended toward a steady rise throughout the day and throughout the week. The definition of the ideal work-curve given at the beginning of this paper seems to have been amply justified.

If human effort in industry is to be used to the best advantage, steadiness at work must be encouraged and useless spurting at the beginning of the day must cease. As Farmer (7) says, "The fast stroke does not always win a rowing race; far more often the slow stroke is more effective, and, generally, such a system is more effective because it is slow and allows for plenty of time to recuperate between each effort. So it must also be in industry."

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COOLING POWER OF THE ATMOSPHERE AND COMFORT DURING WORK*

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INTRODUCTION

ONE of us (L. H., 1) has pointed out that more care should be taken to arrange atmospheric conditions in factories, etc., to suit the nature of the work being done. The heavier the work, the higher will be the cooling power of the atmosphere required to maintain comfort. Observations made in many workshops where vigorous muscular work was done showed that the cooling power of the atmosphere as measured by Hill's kata-thermometer was far too low, and that sweating and discomfort were inevitable. In these workshops no one seemed interested in the matter and no one was sufficiently skilled to regulate the ventilation in order to produce a suitable cooling power.

In the present paper we endeavor to prove from physiological experiments that there are fundamental reasons why more attention should be paid to these matters. From what has already been published by workers on respiratory exchange and metabolism during muscular work, it seems to us that no great attention has been paid by them to the effects of unsuitable atmospheric and bodily conditions. Their experiments have nearly all been carried out with the subject very lightly clothed, and not under such ill ventilated conditions as are often met in workshops where workers, in many cases, wear their usual clothes.

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METHODS

Most of our experiments were carried out on a trained subject, C. P., who has been employed in such experiments for nearly two years. Many experiments were done with ourselves as subjects, with results very similar to those for our subject C. P. Only short periods of work are considered here.

For respiratory exchange we used the Douglas-Haldane method as recommended by Cathcart (2). For observations on resting metabolism a ten-minute sample was usually taken, while during work at a controlled rate and lift of weight, a three-minute sample was found to be sufficient. The sample was collected during the last three minutes of work, care being taken that the general conditions were not affected by the collection. Duplicate analyses were made of every sample of expired air, the average result being used for the calculation. Readings from wet and dry bulb thermometers, from wet and dry kata-thermometers, from axillary and cheek temperatures and the rate of pulse were recorded. The pulse was counted both while the subject was at work and immediately after he stopped work.

To obtain various kata-thermometer cooling powers we used three rooms: an ordinary laboratory room with a gas fire and well ventilated by windows opened enough for comfort during sedentary work—that is, with a dry kata-thermometer cooling power of about 6 to 7 milli-

calories per square centimeter per second; a warm, stagnant room with a dry kata-thermometer cooling power varying from 3.9 to 5 millicalories per square centimeter per second; and a long, narrow, closed passage fitted up as a wind tunnel with a large fan at one end which could be driven at various rates to produce winds of various speeds; as this tunnel was out of doors and not artificially heated, the cooling power during our experiments in winter was about 10 millicalories per square centimeter per second with the fan at rest, and of course much higher—about 25—if the fan was used.

From the results given in the tables it will be observed that we have expressed the body heat production in millicalories per square centimeter per second, as this is the method of expressing heat loss as measured by the kata-thermometer. The body heat production is also expressed in terms of calories *per diem*. The observations were made a few hours after a light meal, consisting mainly of carbohydrate.

Cooling Power and Efficiency

The results of the experiments performed in order to determine the effect of cooling power on efficiency are given in Table 1. In determining the efficiency we have followed fairly closely the methods of Benedict and Cathcart (3). The terms "gross efficiency" and "net efficiency" are employed by us with their usual meaning. Thus, gross efficiency means the number of calories, used up by the external work, expressed as percentage of the total calories found; while net efficiency means the number of calories, used up by the external work, expressed as percentage of the total calories minus the metabolism while the subject is sitting at rest on the ergometer. The efficiency designated "E" on Table 1 was obtained by using the total calories found and the total kilogrammeters of work performed in each experiment marked B as the basal figures for each experiment marked C; in each experiment B, a smaller amount of work was performed than in each experiment C. We have taken the usual standard figures 0.00234 Calories as representing the heat used in the performance of 1 kilogrammeter of external work. In all experiments B and C shown in Table 1, the rate of pedalling was about seventy revolutions per minute, this rate being the most suitable, as pointed out by Benedict and Cathcart (3). In each experiment B, the subject worked against a pressure of 2 kg., and in each experiment C against a pressure of 2.5 kg., Schuster's (4) modification of Martin's bicycle ergometer being employed.

From Table 1, it will be seen that we carried out experiments with dry kata cooling powers varying from 3.9 in the warm room to 11.2 in the cool tunnel, with practically no change in the muscular efficiency for the work performed. Thus, in experiment 3B under a cooling power 3.9, we found that the gross efficiency was 15.1 and the net efficiency 18.4; while in experiment 7B under a cooling power 11.2, that is, nearly three times as great, we found practically the same figures for the efficiencies—namely, 14.8 and 18.5, respectively—so that within this great range of cooling power and under the conditions of experiment specified, cooling power had no effect on muscular efficiency. We shall later endeavor to show that with regard to pulse rate and comfort the higher cooling powers possessed great advantage over the lower cooling powers.

In experiment 6A, the subject sat for half an hour in a hot room at 35.5°C.

TABLE 1.—COOLING POWER AND EFFICIENCY

	No. of Experiment	Date[2]	Time	Kata-Thermometer Cooling Power: Dry	Kata-Thermometer Cooling Power: Wet	Temperature: Dry Bulb	Temperature: Wet Bulb	Cheek Temperature	Axillary Temperature	Pulse Rate	Respiratory Quotient	Calories per Diem	Kilogrammeters per Min.	Kilogrammeters Total
				millicalories per sq. cm. per second		°C	°C	°C	°F					
WARM ROOM EXPERIMENTS	1A	4–3–22	11:00-11:35	5.0	15.3	19.5	14.5	34.6	98.2	84	0.812	1760	—	—
	1B	" " "	11:35-11:50	"	"	"	"	35.5	98.0	132	0.936	8580	408	6080
	1C	" " "	11:56-12:10¾	"	"	"	"	35.8	97.8	156	0.967	10550	507	7425
	2A	4–5–22	11:00-11:36	4.2	13.6	22.6	15.3	34.2	96.8	84	0.796	1930	—	—
	2B	" " "	11:36-11:51	"	"	"	"	35.6	94.0	110	0.947	8520	391	5860
	2C	" " "	12:03-12:20	"	"	"	"	35.1	96.5	140	0.977	10100	494	8400
	3A	4–6–22	11:15-11:53	3.9	13.5	22.5	17.0	34.9	97.6	78	0.811	1695	—	—
	3B	" " "	11:53-12:08	"	"	"	"	35.5	97.6	120	0.896	9280	414	6220
	3C	" " "	12:18-12:37	"	"	"	"	35.5	98.8	130	—	—	524	9950
TUNNEL EXPERIMENTS	4A	3-29-22	10:50-11:24	10.3	24.4	6.0	4.0	27.5	96.8	72	0.763	1795	—	—
	4B	" " "	11:26-11:43	"	"	"	"	28.0	98.0	108	0.923	8070	406	6900
	4C	" " "	11:50-12:04	"	"	"	"	31.7	98.0	120	0.927	11000	509	7125
	5A	3-30-22	10:55-11:28	10.8	25.3	5.0	3.0	26.7	98.0	72	0.843	1825	—	—
	5B	" " "	11:33-11:51	"	"	"	"	28.0	98.0	108	0.863	8790	407	7320
	5C	" " "	12:00-12:15	"	"	"	"	30.9	98.0	120	0.862	10250	515	7725
	6A	3-31-22	11:10-11:47	0.0	10.1	35.5	22.2	36.6	98.0	78	—	—	—	—
	6B	" " "	12:03-12:19	10.9	22.5	5.0	3.0	31.6	97.4	104	0.926	8640	399	5990
	6C	" " "	12:25-12:40	"	"	"	"	32.2	97.8	125	0.879	9760	507	7600
	7A	4–4–22	11:00-11:32	11.2	26.8	5.5	4.0	27.5	94.0	71	0.908	1755	—	—
	7B	" " "	11:47-12:02	"	"	"	"	28.5	94.0	108	0.926	9280	407	6100
	7C	" " "	12:08-12:42	"	"	"	"	33.5	96.8	144	0.941	10900	503	17100
MIDNIGHT EXPERIMENTS IN LABORATORY	8A	4-10-22	11:30-12:15	6.3	19.7	16.0	11.0	31.7	97.0	69	0.771	1570	—	—
	8B	" " "	12:15-12:30	"	"	"	"	33.6	97.0	108	0.873	8640	415	6220
	8C	" " "	12:37-12:52	"	"	"	"	34.0	97.4	125	0.897	10250	510	7650
	9A	4-11-22	12:00-12:35	5.7	18.5	17.5	12.5	32.3	97.0	72	0.794	1450	—	—
	9B	" " "	12:38-12:53	"	"	"	"	34.0	97.0	105	0.930	8585	416	6240
	9C	" " "	1:00-1:15	"	"	"	"	34.5	97.2	132	0.954	10450	523	7850

[1]Height of subject—161.2 cm.; weight—58 kg.

DURING EXPERIMENTS WITH SUBJECT C. P.[2]

Body Heat Production	Respiration	Efficiency			Remarks
		Gross	Net	"E"	
millicalories per sq. cm. per second	*l. per minute*	%	%	%	
1.29	5.7	—	—	—	At rest, on ergometer; ordinary clothing; comfortable.
6.28	22.5	15.9	20.0	—	Working on ergometer; ordinary clothing; comfortable.
7.72	29.4	16.1	19.3	20.9	Working on ergometer; ordinary clothing; very hot and uncomfortable, perspiring freely.
1.41	6.2	—	—	—	At rest, on ergometer; ordinary clothing; comfortable; some movement.
6.24	24.5	15.5	20.0	—	Working on ergometer; stripped to waist; comfortable.
7.41	28.6	16.5	20.3	22.1	Working on ergometer; stripped to waist; very hot and uncomfortable, perspiring.
1.24	5.7	—	—	—	At rest, on ergometer; ordinary clothing; comfortable.
6.80	25.4	15.1	18.4	—	Working on ergometer; ordinary clothing; warm.
.	—	—	—	—	Working on ergometer; ordinary clothing. At 12:27, when pulse reached 144, oxygen was administered until 12:37, greatly relieving respiration and reducing pulse to 130; uncomfortably hot and perspiring.
1.31	5.9	—	—	—	At rest, on ergometer; ordinary clothing; comfortable.
5.91	20.9	16.9	21.6	—	Working on ergometer; ordinary clothing; comfortable.
8.00	29.4	15.6	18.5	11.7	Working on ergometer; ordinary clothing; perspiring slightly.
1.33	6.1	—	—	—	At rest, on ergometer; ordinary clothing; comfortable.
6.44	22.1	15.6	19.6	—	Working on ergometer; ordinary clothing; comfortable.
7.51	26.1	16.9	20.0	24.8	Working on ergometer; ordinary clothing; warm.
—	—	—	—	—	Sitting in hot room; ordinary clothing; perspiring slightly.
6.34	22.8	15.6	—	—	Working on ergometer; ordinary clothing; comfortable.
7.15	25.3	16.7	—	27.8	Working on ergometer; ordinary clothing; fairly comfortable.
1.28	5.8	—	—	—	At rest, on ergometer; ordinary clothing; felt cold.
6.80	24.5	14.8	18.5	—	Working on ergometer; ordinary clothing; comfortable.
7.96	29.0	15.6	18.6	19.8	Working on ergometer; ordinary clothing; felt more comfortable than when working in hot room at same rate for half the time. (See Experiment 1C.)
1.15	5.1	—	—	—	At rest, on ergometer; ordinary clothing; rather sleepy.
6.33	22.7	16.1	19.7	—	Working on ergometer; ordinary clothing; rather sleepy.
7.51	26.6	16.7	19.8	20.0	Working on ergometer; ordinary clothing; rather sleepy; perspiring slightly.
1.06	4.8	—	—	—	At rest, on ergometer; ordinary clothing; rather sleepy.
6.28	22.6	16.4	19.7	—	Working on ergometer; ordinary clothing; rather sleepy.
7.66	29.6	16.8	19.7	19.5	Working on ergometer; ordinary clothing; rather sleepy; perspiring slightly.

[2]Arrangement of dates follows the American custom—*i.e.*, month, day of month, year.

just before working in the cool tunnel, in order to see whether previous exposure in such a hot room would affect the efficiency. It will be observed that no marked difference was obtained under such conditions; the efficiencies in experiments 6B and 6C should be compared with those for other experiments marked B and C respectively.

Experiments 8 and 9 were done in the laboratory, under dry kata cooling power of about 6, during the night and the early morning, the usual routine being reversed—*i.e.*, the subject slept during the day. The subject felt very sleepy at night although he had slept well during the day. It will be noticed that the efficiency, compared with that for the day, was not greatly altered under these conditions. We did not carry out experiments in the warm room or in the tunnel during the night.

In Table 1, it will also be observed that the respiratory quotient was raised by muscular work, as was pointed out by Benedict and Cathcart (3).

Cooling Power, Pulse Rate, and Comfort

Many experiments were done with the subject stripped to the waist. From Table 1, it will be noted that in experiments 1B and 1C the subject was clothed; these experiments may be compared with experiments 2B and 2C, respectively, in which the subject was naked to the waist. The dry kata cooling power was 5.0 in experiments 1B and 1C, and 4.2 in experiments 2B and 2C. It was thus warmer during experiments 2B and 2C. Although the subjective symptoms were much alike in both series of experiments, the pulse rate was considerably reduced by the removal of clothing, being 132 in 1B and only 110 in 2B; while it was 156 in 1C and only 140 in 2C, the rates of work being much alike. In another experiment in which the subject was clothed, the pulse was 150 after the subject had been working fourteen minutes at 514 kilogrammeters per minute; whereas, soon afterwards, when he was working stripped to the waist, the pulse was 140 at the end of fourteen minutes' work at 569 kilogrammeters per minute, the cooling power being the same in both cases. Again in experiment 3B under a dry kata cooling power of 3.9, the pulse was 120, while under a dry kata cooling power of 11.2 in experiment 7B the pulse was 108 (see Table 1), the rate of work being much the same in both. In experiment 7C the subject worked for thirty-four minutes at 503 kilogrammeters per minute, under a dry kata cooling power of 11.2, with the object of finding out how long it would take before the pulse reached 156, the figure arrived at in experiment 1C after only fourteen and three-fourths minutes' work under a dry kata cooling power of 5. The pulse having reached only 144 after the thirty-four minutes' work, experiment 7C was stopped.

In experiment 3C, the subject worked at 524 kilogrammeters per minute. When, in nine minutes, the pulse was 144, oxygen was administered for six minutes over a period of nine minutes, with three intervals of one minute for breathing ordinary air. Under the influence of oxygen the breathing, which had become excessive, was greatly relieved and the pulse was reduced to 130 per minute. The subject was still in great discomfort as he was much overheated and perspiring freely, the dry kata cooling power being only 3.9.

In Table 2, we have arranged figures for varying pulse rates and varying cooling powers under otherwise fairly constant conditions for work. It will be observed that the pulse rate varied in-

versely with the cooling power. In this table we have not included figures from the midnight experiments—*i.e.*, experiments 8 and 9 of Table 1—carried out in the laboratory, as all the other experiments were done during the ordinary daily routine and can hardly be compared, with regard to pulse, with the midnight experiments during which the subject was very sleepy and obviously possessed less tone. We did not carry out any experiments in the tunnel or in the warm room at midnight.

TABLE 2.—COOLING POWER AND PULSE IN EXPERIMENTS OF FIFTEEN MINUTES' DURATION, WITH SUBJECT C.P. CLAD IN ORDINARY CLOTHING

Pulse Rate	Kilogrammeters per Minute	Kata-Thermometer Cooling Power Dry
		millicalories per sq. cm. per second
120	515	10.8
120	509	10.3
125	507	10.9
150	514	7.5
156	507	5.0
104	399	10.9
108	406	10.3
108	407	10.8
108	407	11.2
120	414	3.9
132	408	5.0

Benedict and his co-workers and many others claim that pulse rate varies directly with the work done. We have obtained similar results only when the cooling power was kept constant. This appears to us to be a point of fundamental importance. It is obvious that the heart has much more work to do under warm conditions, with low cooling powers, than under cool conditions, with higher cooling powers (see Table 2). In the former case blood is required in the skin for sweating as well as in the muscles for work. As has already been pointed out, the efficiency of muscle as an engine does not appear to be affected during these short periods of work; it is the pulse rate and comfort that are of importance.

We have also given some attention to the amount of cooling that is required to maintain comfort at a given rate of work. We hope to carry out experiments in the tunnel covering long periods and imitating conditions for individual work as closely as possible, and thus to be able to draw up a table showing suitable cooling powers for each degree of work. The temperature during the winter months was too low—that is, the cooling power was too high—in the tunnel for such graduated experiments. Many experiments of short duration done in the tunnel under a high dry kata cooling power—25 millicalories—showed clearly that the subjects preferred to work at a fast rate so that they would not become cold. Obviously under cool conditions a worker would be willing to do more.

Our principal conclusion from the experiments here recorded is that cool conditions have great advantage over warm conditions, mainly because the heart has less work to do and bodily comfort is maintained when the cooling power is high.

We have given little attention to the body temperature; but the temperatures of the axilla and of the cheek are stated in Table 1. More accurate readings could be obtained only by placing a thermo-electric couple in the rectum. We have taken our subject's personal symptoms, comfort, and sweating as an indication of overheating.

Summary

1. Experiments are described which were made for the purpose of reinvestigating physiological reasons why workers experience greater comfort under

ideal atmospheric conditions than under ill conditions.

2. The efficiency—regarding the body as a machine—with which external work was performed during short periods by a trained subject on a bicycle ergometer was not altered by raising the dry kata-thermometer cooling power of the atmosphere from 3.9 to 11.2 millicalories per square centimeter per second.

3. The pulse rate was much reduced and bodily comfort much increased by raising the dry kata-thermometer cooling power of the atmosphere from 3.9 to 11.2. It is considered that the main factor was relief to the heart under the cool air conditions. Such relief keeps off fatigue and enables the individual to work for longer hours in comfort and with content.

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ESTIMATIONS OF MERCURY IN HATTERS' FUR AND IN FELT *

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THE following analyses were made for the purpose of discovering how much mercury is lost by vaporization or by treatment with hot water during various processes in the making of felt hats. We are indebted to the kindness of the John B. Stetson Company for the specimens of fur and felt which formed the material for this study.

After some experimentation the following method was used for the determination of mercury in carrotted fur and felt. In most cases 5 or 10 gm. of material were analyzed. The organic material was destroyed by means of nitric acid and potassium permanganate, and in general the method described by Lomholt and Christiansen (1) was followed.

Ten grams of fur were treated with 100 c.c. of concentrated nitric acid and allowed to stand overnight. In the morning 100 c.c. of water were added and the solution boiled gently, small amounts of powdered potassium permanganate being added from time to time. This was continued until all the organic material was destroyed and an excess of permanganate had been added, as shown by the presence of undissolved manganese dioxide precipitate or a permanganate color after the solution had been boiled for several minutes. The excess permanganate was reduced by boiling the solution with about 0.5 gm. of oxalic acid. At this point the solution should be a practically clear, light straw-colored fluid. Some of the excess nitric acid was removed by boiling, and the remainder nearly neutralized by the addition of solid sodium carbonate, in small amounts in order to prevent loss due to violent effervescing.

With the solution weakly but yet distinctly acid with nitric acid, the mercury was precipitated by means of hydrogen sulphide. This precipitation in nitric acid solution serves to separate the mercury from other heavy metals which may be present. There is some precipitation of sulphur but this is not excessive if too large amounts of nitric acid are avoided. This solution was filtered and the precipitate washed with hot water and dissolved in aqua regia, care being taken to remove the dissolved mercury thoroughly from the filter paper by washing it repeatedly with boiling water. This solution was boiled for about five minutes, and was then filtered in order to remove sulphur, bits of filter paper, etc.

From this point on, Volhard's (2) gravimetric determination of mercury as a sulphide was followed exactly. The solution in aqua regia was neutralized with sodium carbonate and the mercury precipitated as sulphide by boiling the solution with a slight excess of ammonium sulphide. Sodium hydroxide was then added until the solution appeared lighter colored, and as the boiling was continued more sodium hydroxide was added until the solution was perfectly clear. In this way the mercury sulphide was converted into a soluble sodium sulpho-salt, $Hg(SNa)_2$, and from this solution the mercury was reprecipitated as sulphide, in a form which is more easily filtered by the addition of an excess of solid ammonium nitrate. After the ammonia present had been removed

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by boiling, the solution was allowed to stand overnight, and was then filtered through a weighed gooch crucible, and the precipitate dried at 110° to 120° C. and weighed. ($HgS \times 0.8622$=wt. of Hg.)

The chemical equations involved in the reprecipitation are as follows:

$$HgS + 2NaOH + (NH_4)_2S \rightarrow Hg(SNa)_2 + 2NH_4OH$$
$$Hg(SNa)_2 + 2NH_4NO_3 \rightarrow 2NaNO_3 + (NH_4)_2S + HgS$$

In case sulphur is present in the final precipitate of mercury sulphide, it can be removed by boiling the precipitate with sodium sulphite, which transforms the sulphur to soluble thiosulphate according to the equation

$$Na_2SO_3 + S = Na_2S_2O_3$$

Although no sulphur was visibly present, the precipitates of mercury sulphide were treated with sodium sulphite in each case as a precaution against too high results due to sulphur. Good recoveries of varying amounts of mercury from pure mercury solution were made by the foregoing method, as is shown by Table 1.

TABLE 1.—RECOVERIES OF MERCURY FROM SOLUTIONS OF PURE MERCURIC CHLORIDE

Solution No.	Mercury Present *mg.*	Mercury Recovered *mg*
1	10.0	10.2
2	10.0	10.0
3	5.0	4.9
4	20.0	19.4
5	10.0	10.1
6	10.0	9.6
7	5.0	5.1
8	20.0	20.1

The results of analyses of felt in the different stages of hat manufacture are given in Table 2. Duplicate determinations were made in every case and good agreement was obtained.

The specimens analyzed belonged to two lots, the first containing four samples, the second, two. Number 1 was carrotted fur dried in the oven for yellow carrot, dampened sufficiently to make the pelt pliable, and cut. The second specimen had been carrotted, dried in the oven, seasoned for three months in a storage room, then brushed and cut. It is evident that a decided loss of mercury occurs during this "ripening." Number 3 was fur which had gone through the same processes as specimen Number 2, and had then been blown, formed, and sized. Only a slight loss of mercury occurred during these processes, but in the course of the following stages—blocking, shaping, and pressing with hot irons—the greatest loss of mercury occurs, for Number 4, the finished hat, has only a little more than half as much mercury as the sized hat. The next two samples were from another lot, and were sent us by request because we wished to know just what was the loss of mercury in forming. Number 5 was blown fur, and Number 6 part of a cone from the forming machine. The analyses show an appreciable loss of mercury during forming.

TABLE 2.—RESULTS OF ANALYSES OF FELT IN DIFFERENT STAGES OF HAT MANUFACTURE

Specimen	Percentage of Mercury Found
1. Carrotted, dried in oven, cut when wet	2.41
2. Carrotted, dried in oven, seasoned three months	1.88
3. Sized hat	1.69
4. Finished hat	0.85
5. Blown fur	1.30
6. Cone from former	1.06

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A STUDY OF THE MORTALITY OF COAL MINERS, ENGLAND AND WALES*

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THE Mining Industry Act, 1920, Part II[1], sets up executive machinery, through pit committees, district committees and area committees, for the purpose of discussing and making recommendations (among other things) with respect to the safety, health, and welfare of the workers in connection with their work at the mines. It also transfers to the pit committees so established the management of the accommodation and the facilities for taking baths and drying clothes. In Part III this Act further provides, through a levy of 1 penny per ton of the output of each mine, a fund to be applied for purposes connected with the social well-being, recreation, and living conditions of workers in or about coal mines, and with mining education and research; it vests the duty of allocating the fund so raised in a central committee of five, now known as the Miners' Welfare Committee.

Information as to the health of miners is clearly needed for the purposes of the Act, and as a contribution to this information the following study of the mortality of coal miners has been made. The point should here be stressed, however, that entirely satisfactory information as to the health of coal miners can only be obtained by supplementing mortality statistics by information relating to invalidity and lost time.

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[1] The scheme of Part II is contingent upon agreement between masters and men; such agreement has not been reached.

The Decennial Supplements dealing with occupational mortality, issued by the Registrar General, contain information which concerns (1) coal miners in England and Waies taken as a whole; and (2) coal miners employed on the seven largest coal fields separately. Examination of the information published brings out certain points:

1. Great diversity in the death rates has been experienced on the different coal fields, ranging in 1900-1902 from a comparative figure of 675 for Nottingham and Derbyshire to one of 1,006 for Lancashire; and in 1910-1912, from 570 for Nottingham to 941 for Lancashire (see Table 1). These differences are remarkable when the environmental conditions of work and the hours of labor prevailing in the different fields are so closely identical.

2. Four causes of death are of particular importance: (*a*) phthisis; (*b*) pneumonia; (*c*) bronchitis; and (*d*) accidents. The differences between the mortality experienced from these four causes go far to account for the differences in mortality from all causes on the various fields; for instance, the difference, in 1910-1912, between the comparative mortalities experienced by the miner of Nottingham and the miner of Lancashire is 371, of which 294 are accounted for by the differences in mortality from these four causes of death.

3. A close correlation has been found to exist between the order of the coal fields arranged according to mortality and according to the results of ballots taken in 1920 and 1921. (See Table 2.) This correlation suggests that conditions of health form an unconscious impulse underlying social unrest.

These facts appeared to call for closer investigation in order to throw light, if possible, on the influences which lie at

the back of these diverse mortality rates. Application was therefore made, through the Mines Department, to Somerset House for further information, which has been courteously provided for 1910-1912. Deaths in these years, as far as available information permitted, have been grouped according to whether the deceased had worked (*a*) at the coal face, (*b*) otherwise underground, or (*c*) above ground. The information so obtained is stated in the accompanying tables, most of which have been compiled by the statistical branch of the Mines Department.

Mortality from All Causes

Examination of the standardized death rates set forth in Table 5 brings out certain points of interest with regard to the occupational grouping.

Workers at the Face.—The Lancashire worker stands at the top of the list, holding this position from age 20 to age 65; Staffordshire comes second; Northumberland and Durham third; and Yorkshire fourth. The Monmouthshire and South Wales district, coming last but one, is notably out of the position accorded to it in Table 1.

TABLE 1.—COMPARATIVE MORTALITY AMONG COAL MINERS, AGES 25-64, INCLUSIVE

Coal Field	1910-1912					1900-1902				
	All Causes	Phthisis	Pneumonia	Bronchitis	Accidents	All Causes	Phthisis	Pneumonia	Bronchitis	Accidents
Nottinghamshire[1]	570	53	40	25	66	675	64	52	49	80
Derbyshire[1]	591	70	34	39	73					
Northumberland and Durham	635	70	54	33	83	763	84	54	41	105
Staffordshire	717	74	70	61	109	846	66	71	104	118
Yorkshire	758	81	69	45	117	783	88	71	67	99
Monmouthshire and South Wales	777	70	69	66	131	951	93	108	104	169
Lancashire	941	107	100	88	183	1,006	96	149	113	131
All coal fields	727	76	64	51	118	885	89	86	79	123
Occupied and retired males	790	142	66	38	47	1,004	187	92	58	58

[1] Nottinghamshire and Derbyshire were grouped together previous to 1910-1912.

TABLE 2.—MORTALITY AND UNREST AMONG COAL MINERS

Coal Field[1]	Comparative Mortality 1910-1912 Due to					Percentage of Miners Polling That Voted	
	Respiratory Diseases			Accidents	All Causes	For Strike August, 1920	Against Resuming Work June, 1921
	Phthisis	Bronchitis	Pneumonia				
Nottinghamshire	53	25	40	66	570	55.1	53.7
Derbyshire	70	39	34	73	591	71.8	52.7
Northumberland and Durham	70	33	54	83	635	69.9	66.7
Yorkshire[2]	81	45	69	117	758	51.1	65.3
Monmouthshire and South Wales	70	66	69	131	774	77.9	73.0
Lancashire	107	88	100	183	941	90.6	89.6

[1] Staffordshire, although its mortality is given by the Registrar General, is excluded because the figures regarding the votes on this field were not available.

[2] A strike of six weeks' duration occurred on this field alone in 1919, which was considered to affect the ballot of 1920. When Yorkshire started even with the other fields after the strike in 1920, the ballot figures of 1921 placed this field close to the position ascribed to it by mortality data.

TABLE 3.—NUMBER OF MALES EMPLOYED AT COAL MINES IN ENGLAND AND WALES IN 1911 (INCLUDING RETIRED COLLIERY WORKERS) CLASSIFIED ACCORDING TO AGE AND WORKING POSITION

District	Age Group								
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Total 15 Years and Over
				(a) Workers at the Face					
Northumberland and Durham	2,188	13,322	31,430	22,360	13,028	6,127	3,146	1,092	92,693
Lancashire	2,399	6,831	16,937	13,770	9,216	4,564	1,692	348	55,757
Yorkshire	2,993	11,087	25,890	20,139	11,533	5,697	1,970	373	79,682
Derbyshire	2,364	6,248	11,497	8,301	4,793	2,532	967	213	36,915
Nottinghamshire ...	1,750	4,178	7,903	5,763	3,339	1,688	623	143	25,387
Staffordshire	1,611	5,013	10,647	8,181	5,152	2,810	1,231	313	34,958
Monmouthshire and South Wales	27,099	23,297	36,738	26,565	13,849	5,849	2,019	453	135,869
Other districts......	3,589	7,915	14,936	10,887	6,307	3,394	1,534	459	49,021
England and Wales (all districts)....	43,993	77,891	155,978	115,966	67,217	32,661	13,182	3,394	510,282
				(b) Other Workers below Ground					
Northumberland and Durham	29,098	13,360	12,169	10,533	8,484	6,310	2,063	165	82,182
Lancashire	9,480	6,766	7,211	5,058	3,336	1,753	529	58	34,191
Yorkshire	16,456	7,001	6,855	4,583	2,743	1,427	481	55	39,601
Derbyshire	6,641	1,458	1,542	1,305	881	528	153	11	12,519
Nottinghamshire ...	4,009	884	1,025	850	584	370	105	13	7,840
Staffordshire	6,027	2,629	2,427	1,875	1,209	721	244	32	15,224
Monmouthshire and South Wales	4,450	8,338	17,829	13,382	7,693	3,773	1,135	109	56,709
Other districts......	5,815	2,573	2,941	2,433	1,647	1,041	377	60	16,887
England and Wales (all districts)....	81,976	43,009	51,999	40,019	26,637	15,923	5,087	503	265,153
				(c) Workers above Ground					
Northumberland and Durham	5,279	3,074	3,996	2,845	2,317	1,772	798	104	20,185
Lancashire	1,898	1,230	2,016	1,834	1,480	1,127	455	45	10,085
Yorkshire	2,853	1,773	3,056	2,153	1,828	1,190	510	53	13,716
Derbyshire	1,355	891	1,366	1,181	882	685	349	47	6,756
Nottinghamshire ..	859	581	904	777	667	485	224	43	4,540
Staffordshire	1,415	827	1,274	1,156	939	734	333	46	6,754
Monmouthshire and South Wales	1,582	1,173	3,887	3,281	2,394	1,477	614	90	15,128
Other districts......	1,924	1,031	1,182	1,305	1,121	884	412	70	8,232
England and Wales	17,195	11,180	17,981	14,832	11,631	8,354	3,725	498	85,396
Total (a) (b) (c)	113,164	132,080	225,958	170,817	105,485	56,938	21,994	4,395	860,831
No. per 1,000....	166	154	262	198	123	66	26	5	1,000

TABLE 4.—NUMBER OF DEATHS AMONG MALES EMPLOYED AT COAL MINES IN ENGLAND AND WALES DURING THE YEARS 1910 TO 1912 (INCLUDING THOSE RETIRED FROM WORK AT DEATH), CLASSIFIED ACCORDING TO AGE AT DEATH AND WORKING POSITION

District	Age Group								
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Total 15 Years and Over
(a) Workers at the Face									
Northumberland and Durham	70	174	395	439	508	697	858	545	3,686
Lancashire	16	91	319	365	464	606	588	270	2,719
Yorkshire	32	106	322	425	470	597	632	301	2,885
Derbyshire	22	53	120	139	161	219	289	145	1,148
Nottinghamshire ...	15	30	79	90	111	124	134	82	665
Staffordshire	19	55	149	185	234	303	431	245	1,621
Monmouthshire and South Wales	193	214	374	468	514	579	567	228	3,137
Other districts......	61	113	257	249	251	339	466	366	2,102
England and Wales (all districts)....	428	836	2,015	2,360	2,713	3,464	3,965	2,182	17,963
(b) Other Workers below Ground									
Northumberland and Durham	242	104	116	154	198	319	323	178	1,634
Lancashire	153	123	143	128	148	152	78	32	957
Yorkshire	173	120	103	95	93	115	81	35	815
Derbyshire	59	13	11	16	21	28	31	24	203
Nottinghamshire ...	27	9	11	12	18	26	26	14	143
Staffordshire	46	31	17	25	34	28	27	12	220
Monmouthshire and South Wales	62	122	325	364	370	400	303	95	2,041
Other districts......	28	17	20	17	34	45	45	33	239
England and Wales (all districts)....	790	539	746	811	916	1,113	914	423	6,252
(c) Workers above Ground									
Northumberland and Durham	45	41	47	50	70	93	127	83	556
Lancashire	12	16	37	30	56	98	72	31	352
Yorkshire	32	26	39	44	69	96	100	32	438
Derbyshire	14	7	15	15	22	36	47	32	188
Nottinghamshire ...	2	9	5	9	20	27	35	27	134
Staffordshire	9	7	13	15	21	40	33	22	160
Monmouthshire and South Wales	19	24	48	88	96	129	93	46	543
Other districts......	11	11	14	13	21	40	43	46	199
England and Wales (all districts)....	144	141	218	264	375	559	550	319	2,570

TABLE 5.—MEAN ANNUAL DEATH RATE AMONG COAL MINERS IN ENGLAND AND WALES, AGED 15 YEARS AND OVER, PER 1,000 LIVING (INCLUDING THOSE OCCUPIED AND RETIRED FROM WORK) DURING THE YEARS 1910 TO 1912, FROM ALL CAUSES, ACCORDING TO AGE AT DEATH AND WORKING POSITION[1]

District	Age Group								15 Years and Over	
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Crude Death Rate	Standardized Death Rate
					(a) Workers at the Face					
Northumberland and Durham	10.66	4.35	4.19	6.54	13.00	37.92	90.91	166.36	13.26	12.13
Lancashire	2.22	4.44	6.28	8.84	16.78	44.26	115.84	258.62	16.26	13.74
Yorkshire	3.56	3.19	4.15	7.03	13.58	34.93	106.94	268.99	12.07	11.66
Derbyshire	3.10	2.83	3.48	5.58	11.20	28.83	99.62	226.92	10.37	9.97
Nottinghamshire	2.86	2.39	3.33	5.21	11.08	24.49	71.70	191.14	8.73	8.55
Staffordshire	3.93	3.66	4.66	7.54	15.11	35.94	116.71	260.92	15.46	12.50
Monmouthshire and South Wales	2.37	3.06	3.39	5.87	12.37	33.00	93.61	167.77	7.70	9.89
Other districts	5.67	4.76	5.74	7.02	13.27	33.29	101.26	265.80	14.30	12.48
England and Wales (all districts)	3.24	3.58	4.31	6.78	13.45	35.35	100.26	214.30	11.73	11.23
					(b) Other Workers below Ground					
Northumberland and Durham	2.77	2.59	3.18	4.87	7.78	16.85	52.19	359.60	6.63	7.88
Lancashire	5.38	6.06	6.61	8.44	14.79	28.90	49.15	183.91	9.33	11.15
Yorkshire	3.50	5.71	5.01	6.91	11.30	26.86	56.13	212.12	6.86	9.82
Derbyshire	2.96	2.97	2.38	4.09	7.95	17.68	67.54	727.27	5.41	9.92
Nottinghamshire	2.24	3.39	3.58	4.71	10.27	23.42	82.54	358.97	6.08	9.51
Staffordshire	2.54	3.93	2.33	4.44	8.93	12.94	36.89	125.00	4.82	6.05
Monmouthshire and South Wales	4.64	4.88	6.08	9.07	16.03	35.34	88.99	290.52	12.00	12.98
Other districts	1.60	2.20	2.27	2.33	6.80	14.41	39.78	183.33	4.72	5.40
England and Wales (all districts)	3.21	4.18	4.78	6.76	11.46	23.30	59.89	280.32	7.86	9.67
					(c) Workers above Ground					
Northumberland and Durham	2.84	4.45	3.92	5.86	10.07	17.49	53.05	206.03	9.18	8.45
Lancashire	2.11	4.34	6.12	5.45	12.61	28.99	52.75	220.63	11.63	9.69
Yorkshire	3.74	4.89	4.25	5.98	12.58	26.89	65.36	201.26	10.64	9.70
Derbyshire	3.44	2.62	3.66	4.23	8.31	17.52	44.89	226.95	9.28	7.25
Nottinghamshire	0.78	5.16	1.84	3.86	10.00	18.56	52.08	209.30	9.84	7.03
Staffordshire	2.08	2.82	3.40	1.33	7.45	18.17	33.03	159.42	7.90	6.30
Monmouthshire and South Wales	4.00	4.51	4.12	8.94	13.37	29.11	48.14	170.37	11.96	9.88
Other districts	1.91	3.56	3.15	3.32	6.23	15.08	34.80	219.05	8.06	6.14
England and Wales (all districts)	2.79	4.20	4.01	5.93	10.75	22.30	49.22	213.52	10.03	8.48

[1]For the purpose of standardization, the age distribution of the coal miners in each district and occupation has been assumed to be identical with that of all coal miners in all occupations in England and Wales.

Others below Ground.—For this group, throughout the period of working life, Monmouthshire and South Wales are found at the top of the list, holding this premier place except for the age periods up to 34 years, for which Lancashire leads. Lancashire easily holds the second place, while Staffordshire comes last.

Workers above Ground.—The information for this group is probably least reliable. The "occupational" classification of the Census of Population involves the omission of particular classes of colliery workpeople from the scope of the inquiry—*e.g.*, clerks, bricklayers, carpenters, fitters, blacksmiths, enginemen, etc. Comparison with the results of the "industrial" classification introduced into the Census of Population in 1911 shows that 82,000 workers of 15 years of age and over were recorded under such headings as those referred to above. For this reason the mortality rates for workers above ground need to be accepted with caution.

Taking the data as they stand, the Monmouthshire and South Wales district is found at the top, followed by Yorkshire and Lancashire; Staffordshire again comes last.

Possible Influences.—The inclusion of deaths from accidents might be suspected to control the order observed, but reference to the data of Table 7 shows that what has been said above for the death rates from all causes applies with but little modification to the standardized death rates from all causes exclusive of accidents.

The unenviable position held by Lancashire for each occupational group suggests that conditions apart from mining may be materially affecting the death rate. Reference to the general mortality of the districts gives some support to this suggestion.

The death rates from all causes and from phthisis, for males and females, are stated for the districts in Table 6. The death rates from all causes among males show a tendency to agree with the order of Table 1; but the tendency is less pronounced when the death rates from phthisis alone are considered.

Since the number of miners in some counties, such as Glamorgan, might be held to influence considerably the mortality among males, the mortality among females may, perhaps, be taken as a more useful measure of local influences, such as climate and density of population. The death rate from all causes among females is found to be highest in

TABLE 6.—DEATH RATE OF GENERAL POPULATION (1901-1910)

County	Death Rate per 1,000 Living: All Causes, Males	All Causes, Females	Phthisis, Males	Phthisis, Females
Derbyshire	15.52	13.48	0.66	0.50
Nottinghamshire	16.46	14.48	0.66	0.55
South Wales	18.18[1]	15.92[1]	0.66[1]	0.68[1]
Monmouthshire	16.77	15.11	0.53	0.54
Staffordshire	17.76	15.28	0.72	0.54
Northumberland	18.59	16.23	1.00	0.84
Yorkshire, West Riding	18.27	15.45	0.76	0.55
Durham	18.63	16.65	0.88	0.83
Lancashire	20.64	17.44	0.94	0.67
England and Wales	16.60	13.95	0.78	0.58

[1] This relates to Glamorgan only where the bulk of the South Wales coal field, outside Monmouth, lies.

TABLE 7.—MEAN ANNUAL DEATH RATE PER 1,000 COAL MINERS
AND WALES, CLASSIFIED ACCORDING

A. Crude Death Rates

District	Phthisis, Bronchitis and Pneumonia	Accidents	Other Diseases	Total	Total Exclusive of Accidents
(a) Workers at the Face					
Northumberland and Durham	2.90	1.39	8.97	13.26	11.87
Lancashire	5.06	2.17	9.03	16.26	14.09
Yorkshire	3.24	1.20	7.63	12.07	10.87
Derbyshire	2.50	0.95	6.92	10.37	9.42
Nottinghamshire	2.03	0.98	5.72	8.73	7.75
Staffordshire	4.25	1.43	9.78	15.46	14.03
Monmouthshire and South Wales	2.11	1.17	4.42	7.70	6.53
Other districts	3.46	2.52	8.32	14.30	11.78
England and Wales	3.04	1.45	7.24	11.73	10.28
(b) Other Workers below Ground					
Northumberland and Durham	1.53	0.98	4.12	6.63	5.65
Lancashire	2.29	3.40	3.64	9.33	5.93
Yorkshire	1.43	2.27	3.16	6.86	4.59
Derbyshire	1.01	1.44	2.96	5.41	3.97
Nottinghamshire	1.70	0.77	3.61	6.08	5.31
Staffordshire	1.03	1.69	2.10	4.82	3.13
Monmouthshire and South Wales	2.85	2.87	6.28	12.00	9.13
Other districts	1.01	0.99	2.72	4.72	3.75
England and Wales	1.81	1.95	4.10	7.86	5.91
(c) Workers above Ground					
Northumberland and Durham	2.50	0.68	6.00	9.18	8.50
Lancashire	3.64	1.22	6.77	11.63	10.41
Yorkshire	2.59	1.17	6.88	10.61	9.47
Derbyshire	2.46	0.59	6.23	9.28	8.69
Nottinghamshire	2.86	0.22	6.76	9.81	9.62
Staffordshire	2.12	1.14	4.64	7.90	6.76
Monmouthshire and South Wales	2.78	1.43	7.75	11.96	10.53
Other districts	2.03	0.36	5.67	8.06	7.70
England and Wales	2.64	0.93	6.46	10.03	9.10

[1] For the purpose of standardization, the age distribution of the coal
that of coal miners in all occupations in England and Wales.

15 YEARS OF AGE AND OVER LIVING IN 1910 TO 1912 IN ENGLAND TO DISTRICT AND CAUSE OF DEATH

B. Standardized Death Rates[1]

Phthisis, Bronchitis and Pneumonia	Accidents	Other Diseases	Total	Total Exclusive of Accidents	District
		(a) Workers at the Face			
2.80	1.50	7.83	12.13	10.63	Northumberland and .... Durham
4.30	1.90	7.54	13.74	11.84	.... Lancashire
3.15	1.06	7.45	11.66	10.60	.... Yorkshire
2.46	0.90	6.61	9.97	9.07	.... Derbyshire
2.04	0.96	5.55	8.55	7.59	.. Nottinghamshire
3.50	1.39	7.61	12.50	11.11	..... Staffordshire
2.76	1.23	5.90	9.89	8.66	Monmouthshire and .... South Wales
3.07	2.53	7.88	12.48	9.95	......Other districts
2.93	1.42	6.88	11.23	9.81	.England and Wales
		(b) Other Workers below Ground			
1.74	0.90	5.24	7.88	6.98	Northumberland and .... Durham
2.93	3.46	4.76	11.15	7.69	.... Lancashire
1.90	2.67	5.25	9.82	7.15	.... Yorkshire
2.16	1.57	6.19	9.92	8.35	.... Derbyshire
2.91	0.59	6.01	9.51	8.92	.. Nottinghamshire
1.30	1.72	3.03	6.05	4.33	..... Staffordshire
3.00	2.92	7.06	12.98	10.06	Monmouthshire and .... South Wales
1.11	1.13	3.16	5.40	4.27	......Other districts
2.21	2.03	5.43	9.67	7.64	.England and Wales
		(c) Workers above Ground			
2.40	0.62	5.43	8.45	7.83	Northumberland and .... Durham
3.04	1.11	5.54	9.69	8.58	.... Lancashire
2.51	1.10	6.09	9.70	8.60	.... Yorkshire
2.00	0.60	4.65	7.25	6.65	.... Derbyshire
2.31	0.21	4.51	7.03	6.82	.. Nottinghamshire
1.68	1.00	3.62	6.30	5.30	..... Staffordshire
2.34	1.37	6.17	9.88	8.51	Monmouthshire and .... South Wales
1.62	0.37	4.12	6.11	5.74	......Other districts
2.34	0.86	5.28	8.48	7.62	.England and Wales

miners in each district and occupation has been assumed to be identical with

Lancashire, and lowest in Derby and Nottingham; thus the position of these counties is in agreement with the order of Table 1. The magnitude of the differences between the highest and the lowest death rates is far less than it is in Table 1, however, while the order of the other counties in no way conforms to that order. The death rates from phthisis among females exhibit no similarity with the order of Table 1.

The conclusion seems fair that local conditions must be held to contribute something to the differences in mortality rates found to exist among coal miners, but that inquiry must be made within the industry to ascertain why these differences are so accentuated.

The mortality experienced within the industry from the four causes of death already referred to, distributed according to coal field and occupation of workers, is stated in Table 7. Consideration follows of the facts which emerge.

Phthisis

The incidence of phthisis among coal miners, not only in Great Britain but in other countries, is lower than that found in other occupations, with the exception of agriculture. This fact was particularly noted by Wainwright and Nichols who carried out certain experiments in which they exposed guinea-pigs for about two months to the inhalation of coal dust, and then injected a culture of tubercle bacilli into them. Such anthracosed animals are stated to have developed "extensive tuberculosis of the abdominal viscera, and of the glands round the tracheal injection, *but the lungs were free;*" while control animals are stated to have developed "extensive tuberculosis of the lungs and abdominal viscera." Such facts have been instanced to support the claim that coal dust in some way protects against phthisis. Certainly the data in Table 1 are in support of the observation that coal miners as a class experience a low mortality rate from phthisis, but some explanation must be sought for differences in prevalence of the disease on the various fields, such as, for instance, a comparative mortality figure of 64 in 1900-1902 for Nottingham and Derbyshire and of 96 for Lancashire, and of 53 in 1910-1912 for Nottingham and of 107 for Lancashire.

Distribution by Occupation

Should coal dust possess the power claimed for it, workers at the coal face might be expected to experience a lower mortality from phthisis than other workers underground, and others underground a lower mortality than those employed above ground.

All Coal Miners.—The mortality data set forth in Table 8, however, do not justify this anticipation. Here throughout life the mortality from phthisis for men working at the coal face is found to be higher than for others below ground, and, except for ages 20 to 34 inclusive, higher than for those working above ground. Workers above ground, on the other hand, up to age 55, suffer rather more than others below ground. These data do not support the supposition that coal dust protects the workers against phthisis.

The Separate Coal Fields.—The number of deaths due to each cause occurring on each coal field when distributed according to age and occupation is rather too small to justify reliance upon each death rate stated in the tables which follow, but the general trend can be traced. A further table (Table 9) is added in which the comparative mortality for ages 25 to 64, inclusive, is stated,

TABLE 8.—MEAN ANNUAL DEATH RATE OF COAL MINERS FROM PHTHISIS[1]

District	Age Group								15 Years and Over	
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Crude Death Rate	Standardized Death Rate
(a) Workers at the Face										
Northumberland and Durham	1.98	1.18	1.00	1.04	1.02	2.01	1.38	0.31	1.13	1.27
Lancashire	0.83	0.59	0.91	1.94	2.42	2.63	1.97	0.96	1.54	1.38
Yorkshire	1.11	0.75	0.72	1.19	1.82	2.34	2.88	— —	1.18	1.78
Derbyshire	1.13	0.85	0.87	0.88	1.39	1.71	1.38	— —	1.02	1.04
Nottinghamshire	0.95	0.80	0.80	0.35	0.80	0.99	— —	— —	0.70	0.72
Staffordshire	1.45	0.80	1.19	1.10	1.75	1.07	1.35	1.06	1.20	1.22
Monmouthshire and South Wales	0.30	0.66	0.45	0.85	1.35	1.60	1.49	— —	0.69	0.75
Other districts	1.67	0.84	1.27	1.26	1.58	0.98	1.09	1.45	1.24	1.28
England and Wales (all districts)	0.69	0.80	0.83	1.11	1.54	1.82	1.59	0.49	1.05	1.03
(b) Other Workers below Ground										
Northumberland and Durham	0.46	0.85	0.79	0.82	0.75	0.58	0.48	— —	0.66	0.72
Lancashire	0.28	0.54	1.02	0.79	1.40	1.33	0.63	— —	0.73	0.83
Yorkshire	0.67	0.86	0.68	0.51	0.73	0.47	0.69	— —	0.68	0.66
Derbyshire	0.40	0.23	0.22	0.26	1.14	1.26	— —	— —	0.43	0.43
Nottinghamshire	0.42	0.38	1.63	0.39	0.57	2.70	— —	— —	0.68	0.88
Staffordshire	0.33	0.63	0.27	0.71	0.26	0.46	— —	— —	0.42	0.43
Monmouthshire and South Wales	0.15	0.32	0.97	1.00	1.13	1.77	0.88	— —	0.89	0.81
Other districts	0.46	0.26	0.45	0.41	0.40	0.32	— —	— —	0.39	0.39
England and Wales (all districts)	0.45	0.62	0.83	0.78	0.90	0.98	0.52	— —	0.68	0.73
(c) Workers above Ground										
Northumberland and Durham	0.95	1.95	1.17	1.05	1.01	0.19	— —	— —	1.06	1.11
Lancashire	1.05	1.90	0.99	0.91	1.35	0.59	— —	— —	1.06	1.11
Yorkshire	0.23	2.82	1.09	0.54	0.91	1.12	— —	— —	0.97	1.05
Derbyshire	0.74	0.75	0.98	0.56	1.13	0.49	— —	— —	0.74	0.78
Nottinghamshire	0.39	2.29	0.74	— —	— —	2.06	— —	— —	0.73	0.75
Staffordshire	— —	0.81	0.78	— —	0.71	0.91	1.00	— —	0.49	0.50
Monmouthshire and South Wales	0.21	0.38	0.51	2.03	1.11	1.13	1.04	— —	0.97	0.87
Other districts	0.35	0.97	0.90	1.02	0.30	0.38	1.62	— —	0.69	0.75
England and Wales (all districts)	0.58	1.58	0.91	0.99	0.92	0.76	0.45	— —	0.91	0.95

[1] For the purpose of standardization, the age distribution of the coal miners in each district and occupation has been assumed to be identical with that of all coal miners in all occupations in England and Wales.

i.e., for the period of life when occupational influence may be expected to be established and when productivity is most pronounced—the period which the Registrar General considers as the most useful for comparative purposes.

The tendency for men at the face to suffer more from phthisis than others below ground is found to hold good throughout life, and for each field (except Nottingham and South Wales); the tendency is most marked, 1.22 as compared with 0.43, for Staffordshire, and Yorkshire, 1.78 as compared with 0.66, for the field where the phthisis mortality is highest. Nottingham and Monmouthshire and South Wales present exceptions in that workers at the face suffer less from phthisis than others below ground and than those above ground; indeed, on these fields the standardized death rates from phthisis for workers at all ages at the face are less than on any field.

TABLE 9.—COMPARATIVE MORTALITY FROM PHTHISIS AMONG COAL MINERS, AGED 25-64, CLASSIFIED ACCORDING TO COAL FIELDS AND WORKING POSITION, FOR THE PERIOD 1910-1912

Coal Field	Occupational Group Workers at Face	Others below Ground	Workers above Ground
Northumberland and Durham....	81	55	69
Lancashire	125	77	71
Yorkshire	92	44	64
Derbyshire	77	40	59
Nottinghamshire..	49	85	39
Staffordshire	89	29	39
Monmouthshire and So. Wales..	64	79	81
England and Wales	85	60	65

With a disease like phthisis, which is more prevalent at some ages than at others, the distribution of the disease according to age must be considered. In Yorkshire, which stands at the top of the list, workers above ground suffer more up to the age of 35. In Lancashire, which comes second, the position resembles that of Yorkshire. In Northumberland and Durham, which comes third, those at the face do not suffer more until after age 54. In Staffordshire, which comes fourth, those at the face suffer more throughout life. In Derbyshire the tendency is for those at the face to suffer more through life, but the data for this field and for Nottinghamshire, where the reverse holds good, are too few to rely upon. In Monmouthshire and South Wales the position is unusual; up to age 24 workers at the face lead, then for ages 25 to 44, inclusive, workers below ground lead, and finally for ages 45 and over workers at the face again lead.

Generally on all the fields the tendency is for workers at the face, during the latter half of their working life, to suffer markedly more from phthisis than do others employed in the mining industry. Evidence points to the presence of some cumulative adverse influence which especially affects workers at the face.

Pneumonia

The range of comparative mortalities due to pneumonia on the different fields, stated in Table 1, is even wider than that for phthisis; but here, unlike the mortality from phthisis, the mortality from pneumonia among coal miners in 1910-1912, on four fields, exceeded the standard set by occupied and retired males, and in 1900-1902 it exceeded the standard on two fields. Apparently some influence is present on some fields, noticeably Lancashire, but absent on others, which predisposes to pneumonia.

TABLE 10.—MEAN ANNUAL DEATH RATE OF COAL MINERS FROM PNEUMONIA[1]

District	Age Group								15 Years and Over	
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Crude Death Rate	Standardized Death Rate
(a) Workers at the Face										
Northumberland and Durham	0.91	0.23	0.36	0.57	1.10	2.77	4.03	2.44	0.82	0.83
Lancashire	0.14	0.39	0.79	0.87	2.06	3.29	6.50	8.62	1.37	1.15
Yorkshire	0.11	0.27	0.32	0.68	1.42	2.87	6.60	5.36	0.92	0.84
Derbyshire	0.14	0.16	0.26	0.40	0.56	1.32	4.83	— —	0.50	0.48
Nottinghamshire ...	0.38	0.08	0.21	0.58	0.50	1.18	7.49	2.33	0.58	0.59
Staffordshire	— —	0.13	0.50	0.77	1.68	2.85	3.79	4.26	1.00	0.82
Monmouthshire and South Wales	0.15	0.29	0.35	0.59	1.08	2.79	5.28	4.42	0.61	0.75
Other districts......	0.19	0.55	0.38	0.37	1.22	2.16	4.35	2.18	0.76	0.71
England and Wales (all districts)....	0.19	0.28	0.40	0.61	1.27	2.61	5.16	3.63	0.81	0.78
(b) Other Workers below Ground										
Northumberland and Durham	0.19	0.12	0.14	0.35	0.90	1.58	3.07	4.04	0.45	0.47
Lancashire	0.42	0.44	0.60	1.38	2.20	3.23	3.78	5.75	0.98	1.18
Yorkshire	0.20	0.33	0.49	0.80	1.34	1.40	3.47	— —	0.51	0.72
Derbyshire	0.10	0.23	0.22	0.51	0.38	0.63	4.36	30.30	0.29	0.56
Nottinghamshire ...	0.17	0.75	— —	1.57	— —	1.80	6.35	25.64	0.55	0.87
Staffordshire	0.17	0.25	0.27	0.53	1.31	0.46	1.37	— —	0.37	0.47
Monmouthshire and South Wales	0.30	0.44	0.60	0.77	1.43	2.74	5.58	3.06	0.95	0.94
Other districts......	— —	0.13	0.11	0.14	0.61	1.60	0.88	5.56	0.26	0.31
England and Wales (all districts)....	0.20	0.29	0.41	0.70	1.23	1.95	3.60	4.64	0.61	0.72
(c) Workers above Ground										
Northumberland and Durham	0.25	— —	0.42	0.47	1.15	1.69	2.51	12.82	0.66	0.63
Lancashire	0.18	0.54	0.50	0.55	0.90	3.85	5.86	14.81	1.19	0.94
Yorkshire	0.70	— —	0.44	0.54	1.82	2.24	3.27	6.29	0.92	0.83
Derbyshire	0.25	0.37	0.49	— —	0.38	0.97	3.82	— —	0.54	0.44
Nottinghamshire ...	— —	1.15	0.74	0.43	1.00	1.37	1.49	— —	0.73	0.71
Staffordshire	0.46	— —	0.26	0.87	0.71	1.36	2.00	14.49	0.74	0.62
Monmouthshire and South Wales	— —	0.94	0.60	1.12	1.11	2.03	2.07	3.70	0.99	0.86
Other districts......	0.17	— —	0.22	— —	0.59	1.89	4.05	— —	0.57	0.39
England and Wales (all districts)....	0.29	0.30	0.46	0.58	1.06	2.03	2.95	6.69	0.81	0.70

[1] For the purpose of standardization, the age distribution of the coal miners in each district and occupation has been assumed to be identical with that of all coal miners in all occupations in England and Wales.

TABLE 11.—COMPARATIVE MORTALITY FROM PNEUMONIA AMONG COAL MINERS, AGED 25-64, CLASSIFIED ACCORDING TO COAL FIELDS AND WORKING POSITION, FOR THE PERIOD 1910-1912

Coal Field	Occupational Group: Workers at Face	Others below Ground	Workers above Ground
Northumberland and Durham	64	39	54
Lancashire	101	107	74
Yorkshire	71	62	71
Derbyshire	36	28	28
Nottinghamshire	36	49	56
Staffordshire	81	41	48
Monmouthshire and So. Wales	64	79	74
England and Wales	67	62	59

Distribution by Occupation

All Coal Miners.—The mortality from pneumonia among miners distributed according to occupation is given in Tables 10 and 11. Here other workers below ground are found to suffer slightly more than men at the face, up to age 44, after which age men at the face suffer more. Workers above ground in early life, up to age 34, suffer more than either group of underground workers, but for later age periods the mortality is higher among the underground workers.

Separate Coal Fields.—Lancashire stands at the top of each occupational group; at all ages men at the face and below ground suffer nearly equally, but among men at the face there is an excess of the disease after age 65; in the mid-period of life both underground groups suffer more than workers above ground.

In Staffordshire men at the face suffer more than the other two occupational groups, throughout life (except for the unreliable period, ages 75 and over).

In Yorkshire there is a close similarity between the prevalence of the disease among men at the face and the prevalence among those above ground; and throughout life both groups tend to suffer more than others working below ground.

In Monmouthshire and South Wales the tendency is for pneumonia to be more prevalent throughout life among others below ground than among men at the face, and among those above ground. These four fields experience more pneumonia than the standard population.

In Northumberland and Durham men at the face, up to age 64, suffer more than either of the other groups; and those above ground suffer more than others below ground.

In Nottingham and Derby, which stand lowest, men at the face suffer less than others below ground.

The general tendency on the fields where pneumonia is high is for men at the face to suffer more than others below ground; this tendency is reversed in Nottingham and in Monmouthshire and South Wales, the fields where phthisis is also unusual in that it is more prevalent among others below ground than among those at the face.

Bronchitis

As in the case of pneumonia, data in Table 1 disclose a wide range in the mortality from bronchitis among coal miners. In 1900-1902 this mortality on four fields exceeded the standard set by occupied and retired males, and in 1910-1912 this standard was exceeded on five fields. Here, just as in the case of pneumonia, there is evidence of some influence being present on certain fields, noticeably Lancashire, which predisposes to bronchitis.

Distribution by Occupation

All Coal Miners.—The mortality from bronchitis among miners distributed

TABLE 12.—MEAN ANNUAL DEATH RATE OF COAL MINERS FROM BRONCHITIS

District	Age Group								15 Years and Over	
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Crude Death Rate	Standardized Death Rate
					(a) Workers at the Face					
Northumberland and Durham	—	—	0.02	0.15	0.38	3.32	11.76	19.84	0.95	0.71
Lancashire	0.14	—	0.06	0.36	1.48	8.03	26.60	52.68	2.15	1.78
Yorkshire	—	0.03	0.01	0.13	0.64	4.10	20.14	45.58	1.14	1.13
Derbyshire	—	—	0.03	0.08	0.56	3.29	17.92	32.86	0.98	0.94
Nottinghamshire ...	—	—	—	0.06	0.20	1.97	11.24	53.61	0.75	0.73
Staffordshire	—	—	0.06	0.16	1.23	4.98	27.89	47.92	2.05	1.49
Monmouthshire and South Wales	—	0.01	0.03	0.15	0.87	5.70	22.29	31.64	0.81	1.26
Other districts......	—	—	0.02	0.15	0.37	3.73	16.95	62.45	1.46	1.08
England and Wales (all districts)....	0.01	0.01	0.03	0.16	0.74	4.65	18.89	37.22	1.18	1.12
					(b) Other Workers below Ground					
Northumberland and Durham	—	0.07	0.03	0.09	0.47	1.43	5.98	40.40	0.42	0.55
Lancashire	0.04	—	0.14	0.13	0.70	3.42	15.12	28.74	0.58	0.92
Yorkshire	—	—	—	0.15	0.61	1.64	8.32	18.18	0.24	0.52
Derbyshire	—	—	—	0.26	0.38	0.63	4.36	181.82	0.29	1.16
Nottinghamshire ...	—	—	—	—	—	0.90	12.70	153.85	0.47	1.16
Staffordshire	—	—	—	—	0.26	1.39	6.83	20.83	0.24	0.41
Monmouthshire and South Wales	—	0.04	0.04	0.30	1.13	4.59	17.62	55.05	1.01	1.25
Other districts......	—	—	—	—	0.61	0.96	6.19	27.78	0.36	0.44
England and Wales (all districts)....	—	0.03	0.04	0.17	0.69	2.34	9.89	43.07	0.52	0.76
					(c) Workers above Ground					
Northumberland and Durham	—	—	—	0.35	1.01	1.88	7.10	32.05	0.78	0.66
Lancashire	—	0.27	—	0.55	0.90	4.14	11 72	29 63	1.39	0.99
Yorkshire	—	—	—	0.27	0.91	1.40	7.19	37 74	0.70	0.63
Derbyshire	—	—	0.24	0.28	—	3.41	7.64	49.65	1.18	0.79
Nottinghamshire ...	—	—	—	0.43	1.00	2 75	10 42	38.76	1.40	0.85
Staffordshire	—	—	—	—	0.35	5.90	2.00	14.49	0.89	0.56
Monmouthshire and South Wales	0.21	—	0.17	0.10	0.70	2.48	5 69	22.22	0.82	0.61
Other districts......	—	—	—	0.26	0.30	1.51	4.85	33.33	0.77	0.48
England and Wales (all districts)....	0.02	0.03	0.06	0.27	0.72	2.71	6.98	31.46	0.92	0.68

[1] For the purpose of standardization, the age distribution of the coal miners in each district and occupation has been assumed to be identical with that of all coal miners in all occupations in England and Wales.

according to occupation and age is stated in Tables 12 and 13. Men above ground are found to suffer more from bronchitis in early life, men at the face suffer more after age 45, and others below ground after age 65.

Separate Coal Fields.—In Lancashire where the bronchitis mortality is highest, the relative prevalence of the disease by occupation is the same as for all coal miners. In Monmouthshire and South Wales others below ground suffer most up to age 54, after which men at the face suffer most. Men above ground suffer rather less than either group throughout life. In Staffordshire men at the face suffer most, workers above ground coming second. In Yorkshire the same is true. The prevalence of bronchitis on these four fields is above that among the standard population. For Derbyshire the tendency up to age 75 is for men at the face to suffer most from the disease; and on this field, except at the terminal age period, men above ground suffer more than others below ground. In Nottinghamshire the tendency is for men above ground to suffer more throughout life than those underground, but for both underground groups to catch up late in life.

TABLE 13. — COMPARATIVE MORTALITY FROM BRONCHITIS AMONG COAL MINERS, AGED 25-64, CLASSIFIED ACCORDING TO COAL FIELDS AND WORKING POSITION, FOR THE PERIOD 1910-1912

Coal Field	Occupational Group: Workers at Face	Others below Ground	Workers above Ground
Northumberland and Durham ..	42	24	40
Lancashire	108	50	64
Yorkshire	51	28	32
Derbyshire	43	17	45
Nottinghamshire .	23	9	50
Staffordshire	71	17	62
Monmouthshire and South Wales ...	72	68	40
England and Wales	60	36	45

The general tendency is for bronchitis, especially when present in excess, to affect men at the face particularly later in life; but here again the exceptional position of the Monmouthshire and South Wales field is notable.

Accidents

The mortality rate from accidents among coal miners is exactly opposite to that from phthisis in being above the standard for occupied and retired males on all the coal fields, but it resembles the mortalities from phthisis, pneumonia, and bronchitis in showing a marked diversity on the various fields and in being highest where these diseases are most prevalent, and *vice versa.* In 1910-1912 the position of the coal fields arranged in order of merit according to the mortality rate from either pneumonia or accidents was exactly the same, and in 1900-1902 there was also a close similarity.

Distribution by Occupation

All Coal Miners.—The mortality distributed by occupation is stated in Tables 14 and 15. Others below ground are found to suffer the highest mortality from accidents throughout life; men employed at the coal face come next; and those above ground come last.

Separate Coal Fields. — In Lancashire, where the accident rate for ages 25 to 64, like the mortality rate from phthisis, pneumonia, and bronchitis, is the highest on the coal fields, others below ground have a higher mortality throughout life than men at the face, and men at the face a higher mortality than workers above ground. In Monmouthshire and South Wales the position with

TABLE 14.—MEAN ANNUAL DEATH RATE OF COAL MINERS FROM ACCIDENT

District	Age Group								15 Years and Over	
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Crude Death Rate	Standardized Death Rate
				(a) Workers at the Face						
Northumberland and Durham	2.13	1.18	1.08	1.15	1.69	2.45	2.65	3.05	1.39	1.50
Lancashire	0.14	2.10	2.24	2.06	2.46	2.78	2.17	2.87	2.17	1.90
Yorkshire	0.22	0.57	1.33	1.11	1.39	2.05	2.03	0.89	1.20	1.06
Derbyshire	0.42	0.80	0.67	1.16	0.97	1.58	2.07	4.69	0.95	0.90
Nottinghamshire	0.57	0.56	0.67	1.27	0.90	2.57	2.14	2.33	0.98	0.96
Staffordshire	1.24	1.20	1.03	1.43	2.01	2.14	1.08	5.32	1.43	1.39
Monmouthshire and South Wales	1.06	0.82	1.60	1.36	1.40	2.34	2.31	1.47	1.17	1.23
Other districts	2.69	2.15	2.39	2.60	2.85	2.06	4.35	2.90	2.52	2.53
England and Wales (all districts)	1.09	1.10	1.30	1.46	1.73	2.28	2.43	2.85	1.45	1.42
				(b) Other Workers below Ground						
Northumberland and Durham	1.23	0.57	0.71	0.95	1.10	1.27	0.65	— —	0.98	0.90
Lancashire	3.23	3.30	3.10	3.23	4.10	5.13	2.52	11.49	3.40	3.46
Yorkshire	1.48	2.43	2.82	3.05	3.65	2.57	3.47	— —	2.27	2.67
Derbyshire	1.25	1.37	1.08	2.04	2.65	1.26	2.18	— —	1.44	1.57
Nottinghamshire	0.91	1.13	— —	0.39	0.57	1.80	— —	— —	0.77	0.59
Staffordshire	1.55	1.52	0.96	1.42	3.41	4.16	— —	— —	1.69	1.72
Monmouthshire and South Wales	2.92	2.76	2.32	2.84	3.29	4.24	4.70	6.12	2.87	2.92
Other districts	0.40	0.91	1.02	1.10	1.62	1.92	4.42	— —	0.99	1.13
England and Wales (all districts)	1.55	1.84	1.90	2.17	2.57	2.66	2.29	2.65	1.95	2.03
				(c) Workers above Ground						
Northumberland and Durham	0.76	0.43	0.50	0.47	0.72	1.13	1.67	— —	0.68	0.62
Lancashire	0.35	0.54	0.99	0.73	2.70	2.96	—	7.41	1.22	1.11
Yorkshire	1.40	0.19	0.65	1.36	1.28	1.96	1.96	12.58	1.17	1.10
Derbyshire	0.98	0.37	0.98	0.28	— —	0.97	— —	— —	0.59	0.60
Nottinghamshire	— —	0.57	— —	0.43	— —	— —	1.49	— —	0.22	0.21
Staffordshire	0.92	0.81	0.78	0.58	1.42	1.82	4.00	— —	1.14	1.00
Monmouthshire and South Wales	1.69	1.32	0.60	1.63	0.70	2.71	4.66	3.70	1.43	1.37
Other districts	0.17	0.65	0.45	— —	0.59	0.38	— —	4.77	0.36	0.37
England and Wales (all districts)	0.83	0.60	0.63	0.85	1.00	1.68	1.88	3.35	0.93	0.86

[1] For the purpose of standardization, the age distribution of the coal miners in each district and occupation has been assumed to be identical with that of all coal miners in all occupations in England and Wales.

TABLE 15. COMPARATIVE MORTALITY FROM ACCIDENTS AMONG COAL MINERS, AGED 25-64, CLASSIFIED ACCORDING TO COAL FIELDS AND WORKING POSITION, FOR THE PERIOD 1910-1912

Coal Field	Occupational Group: Workers at Face	Others below Ground	Workers above Ground
Northumberland and Durham ..	99	66	45
Lancashire	164	256	109
Yorkshire	98	215	83
Derbyshire	71	121	41
Nottinghamshire..	82	33	9
Staffordshire	107	144	70
Monmouthshire and So. Wales..	97	209	85
England and Wales	112	158	65

regard to those underground is the same, but workers above ground tend to suffer a higher mortality at nearly every age than do men at the face. In Yorkshire the usual position is found, others below ground experiencing more fatal accidents throughout life than men at the face, and men at the face (except after age 75) more than workers above ground. In Staffordshire and in Derbyshire the same is true. In Durham and Northumberland and in Nottinghamshire men at the face are exceptional in heading the list throughout life; others below ground come next; and workers above ground last.

Mortality data for accidents for the years 1910-1912 cannot be discussed without reference to the occurrence of two mining disasters. One, which took place in 1910 at Hulton in Lancashire, caused 344 deaths, and thus raised the total of fatal accidents on that field to 460, as compared with 110 in 1911, and 129 in 1912; the explosion occurred while coal getting was in progress and affected all underground workers alike. The other disaster, which occurred in 1912 at Cadeby in Yorkshire, caused 88 deaths, and thus raised the total of fatal accidents on that field to 247 for that year, as compared with 166 for 1911, and 173 for 1910; this explosion did not affect men at the face as repairing work only was in progress at the time. These two disasters affect the position of the fields concerned as may be seen by calculating the annual accident rate, apart from explosions, for the four fields with the highest rates.

Coal Field	Total Number Employed, 1911[2]	Fatal Accidents (Explosions Excluded), 1910-1912[2]: Number	Annual Death Rate per 1,000
Lancashire	102,894	354	1.15
Yorkshire	148,026	486	1.09
Monmouthshire and So. Wales	220,815	923	1.39
Staffordshire ..	56,270	217	1.29

The general tendency is for others below ground to suffer a higher mortality from accidents than men at the face, and for both groups of underground workers to suffer a higher mortality than workers above ground. But on two fields, where the accident rate is low—Durham and Northumberland, and Nottingham—others below ground suffer less than men at the face; these two fields have already been noted as standing below the average for all coal fields for each of the respiratory diseases.

[2] The data here are estimates made by the Home Office of (*a*) the number employed and (*b*) the deaths attributable to mining accidents.

(*To be Continued*)

MEDICAL EXAMINATION OF EMPLOYEES*

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The general consensus of opinion (lay and medical) endorses the sound axiom that, whenever possible, each employee should be medically examined before being accepted for any kind of work. In all large works this is essential—in the small one it is extremely advisable—in the interests of the employee, the employer, and the community in general. This axiom being accepted, it follows that a form to be filled in should be provided. What the exact nature of this form should be can be determined only after mature consideration, founded on experience and corrected by revision.

The following rules should be adopted in the preparation of forms for medical examination to be filled in by the physician examining the employee:

A. The examination must be strictly confidential, and must not be filed with the general dossier or record of the worker. The forms should, therefore, be headed *Private and Confidential.*

B. The examination should be made by a physician specially qualified for this particular work. For example, the senior surgeon of a large hospital may be as unfitted to decide between functional and organic disease of the heart, as the examining physician would be to perform a complicated abdominal operation. The one is a specialist and aims at knowing everything about something; the other should know something about everything.

C. The forms should be uniform: *(a)* for purpose of comparison; *(b)* for facility in recording statistics; *(c)* for saving time; and *(d)* for economy in their production.

D. The forms should be simple. What is not relevant may always be neglected, but what is omitted in the form may be forgotten. It ensures greater accuracy and prevents the omission of important details.

E. They should be printed: *(a)* on one side only; *(b)* on good paper to avoid destruction; *(c)* in small, clear type, providing ample room for answers; *(d)* on thin paper for reduplication. Two copies are always required, frequently more.

F. Different forms should be printed on differently colored paper.

G. Different forms should be provided for different circumstances: *(a) New employees:* (1) men, (2) women, (3) children —(1) and (2) may appear on the same form, though this is generally not advisable; *(b) Accidents:* (1) original examination. (2) continuation, *i.e.*, subsequent examinations.

It is important that a copy of each report should be filed for ready reference by the physician. At each subsequent examination he should have before him all the worker's previous medical reports.

The following specimen health report is submitted for comment, suggestion, and discussion. As already indicated, it should be headed *Private and Confidential.* Below these words should appear the name of the firm, corporation, or society.

HEALTH REPORT

Part I

Name (of employee). Surname followed by other names. The address may be inserted if necessary. Generally, however, it is unnecessary and therefore should not cumber the report, as it will always appear in his other papers.

Wages No. Sometimes called "Works No.," "Stage No.," etc.

C.P. No.—*i.e.*, Co-partnership.

1. Suitability for this occupation. I have placed this immediately after the worker's name for the convenience of the manager. It is often the only answer at which he looks. It may also be used for suitability for co-partnership, old-age pension, etc. It may be answered "Yes," "No," "Postponed," "For light work only," etc.

2. Age on last birthday. A birth certificate should be procured if possible. In my experience at a military hospital, also at the re-survey board of the Ministry of Pensions, as the pensions representative on the Dispersal Board at a Dispersal Hospital in London, and as medical officer to the Ministry of Munitions, I found that there were two ages—the official age and the real age. In industry it is equally important, as the following incident shows. I once said to a man, "Your birth certificate shows you to be 34; you gave your age last year as 29." "Well, sir," said the

*Received for publication May 13, 1922.

man, "the job was open only to men under 30."

3. Height.

4. Weight.

5. Occupation.

6. Duration of service with this firm (present and previous). If previously employed, mention the reason why he left the company—*e.g.*, slackness of work, ill health, etc.

7. Time lost through illness during the past five years.

8. Date of previous medical reports (health, accident, special, etc.). I attach much importance to this question.

Part II

9. Family history.

10. Previous maladies.

11. Military history—*e.g.*, date of joining the service, together with category; gunshot wounds, illness, accident, etc., during military service, date of demobilization, with category; pension.

12. Sight.

13. Hearing.

14. Teeth.

15. Rupture.

16. General health. Heart, lungs, etc.

17. General remarks.

There are numerous other questions which may appear on a medical report, some of which are advisable, such as, for instance, a urine examination. (There are obvious difficulties in making this test universal.) Other questions which are often included are inadvisable. An example of this type of question is the following: "Is the worker moderate in the use of alcohol?" Not once in ten thousand times does a physician answer this in the negative. The question is nearly always put to the examinee on a life assurance form, and it is always answered in the affirmative, even by the habitual drunkard.

The above is only suggested as a skeleton form to encourage comment. The questions are divided into two parts, the first eight, except under the head of suitability, being of a general character, the remainder of a medical character, and of a specially confidential nature. In all cases where the answers to the questions are on the worker's authority only, the word "stated" should be inserted.

I shall be pleased to consider correspondence containing suggestions and criticisms with reference to the proposed form. Letters should be sent to me at the following address: The Industrial Welfare Society, 51, Palace Street, Westminster.

LABOUR RECORDS IN FACTORIES*

G. M. Broughton, M.A., O.B.E.

Adviser, Labour Bureau, Government of India

The subject of record-keeping in factories is now coming into prominence. The necessity of recording facts relating to output, amount of material used and power consumed, in order that the costs of manufacture may be estimated, has been recognized for some time past. The important part, however, that the human element plays in the enhancement or the lowering of the costs of production has not yet received the same attention. In many factories one finds that practically no records relating to the employees are kept. Almost the only fact that appears to be noted is the employee's name in the wages book. Consequently, in many cases of absence, as even the address of the worker is not known, there are no means of ascertaining whether his absence is merely temporary or whether he has no intention of returning. In this way thousands of workers drift in and out of employment without the factory management having any definite knowledge of the causes influencing this ebb and flow. This condition of affairs is not peculiar to India; it holds good to-day in England among many firms. The reason for this in England is that, in ordinary seasons, the supply of labour is plentiful: in India, on the other hand, though labour is generally difficult to obtain, yet, in view of its nominal cheapness, managers have felt it unnecessary to give special attention to this question.

There are, however, many obvious advantages that immediately accrue as a result of installing a sound system of record-keeping. The writer is taking this opportunity of drawing attention to some of them—and hopes also to answer some of the objections generally brought forward by the opponents of record-keeping. After having dealt with both aspects of this question, it is proposed to make some suggestions regarding record forms. It is not intended to imply that it will be possible for all firms to adopt exactly the same forms. Each firm will necessarily have to make alterations and modifications to adapt the forms to its own requirements. The model forms given here should, however, serve as a useful guide.

A difficulty with which managers are usually confronted is connected with the selection and maintenance of a healthy and efficient working staff. Very little, however, appears to be done directly to achieve this end, beyond the provision of good working conditions. In England some employment superintendents succeed, by means of rough and ready tests, in eliminating applicants who are obviously unfit. Psychological tests of practical ability are, however, gradually being evolved (1) (2). Much thought is being given to this subject in America also (3) (4). In India the scarcity of labour makes selection still more difficult. There is little doubt, however, that Indian employers also would benefit by studying methods of selection. The methods now in vogue are admittedly unsatisfactory—hereditary training and aptitude are neither available nor considered essential for employment in power factories. Owing to the chronic shortage of labour, the employer is apt to engage all persons offering themselves, and very often this important work is left to a contractor who has no interest in the efficiency of the labour which he supplies. The result of this haphazard procedure, or absence of method, becomes immediately evident if an estimate is made of the large proportion of workers who leave after only a few weeks. An enquiry made in England in munition and non-munition factories (5), showed that in many cases over fifty per cent. of those engaged left within the first three months of employment. The proportion is probably much larger in India. In one factory, for example, where the conditions of employment are exceptionally good, it has been calculated that there is a complete labour turn-over once every eighteen months. It will therefore be worth while to take steps to ascertain the causes governing this constant change among the workers. Men are trained, but leave before they have given an economic return for their training. They have to be replaced by fresh, unskilled workers. Output, in consequence, is considerably below the level it would otherwise reach. The workers on their part also suffer, as they seldom attain sufficient skill to earn the highest wages.

As a first step, the writer suggests that a member of the factory staff should be entrusted with the definite task of discovering

*Reprinted from the *Journal of Indian Industries and Labour*, Feb., 1922, 2, Part 1, 64-76.

the reasons why the workers leave. He should also be asked to keep a separate record for each worker. If, as a result, it is found that many are leaving because they have no aptitude or liking for the work, or because they are lacking in physique, then the need for a careful preliminary selection will be at once apparent. If, on the other hand, the men or women leave because they are dissatisfied with any features in the working conditions, then it may be possible to rectify them and so to lessen the exodus from the factory.

Again, the time-keeping in the factory may be unsatisfactory. No steps can be taken to improve it until the cause is discovered. It may be due to faulty transport facilities, to long hours of work and short spells of rest inducing avoidable fatigue, or to hours of work not adapted to the habits and customs of the workers. No doubt, all these matters do receive the constant attention of all competent managers, but it seems to the writer that the best way of discovering, in a systematic manner, the main causes at work is to introduce some machinery whereby the reasons of lateness and bad time-keeping are not only recorded but also studied.

Further, there may be an undue amount of sickness among the workers in one particular department or in the factory as a whole. It ought to be easy to ascertain the causes from properly maintained dispensary records. In her visits to mills and factories the writer has frequently been introduced to the medical staffs. They are almost invariably interested in their duties and anxious to lessen the incidence of sickness in the works. Their time is, however, as a rule, fully occupied with the clinical part of the work and the records relating thereto. Sufficient use is not made of the data thus available. In order, however, that these data may be easily utilized the doctors should be consulted and a standard system of classification should be introduced. The trade association concerned might then appoint a medical man to study the records with a view to discovering what the more general ailments are and their causes, or assistance would probably be given, if desired, by medical experts belonging to the government of India or to the provincial governments.

Besides sickness, accidents also play a large part in lowering output. In this connection the writer wishes to draw attention to the "Safety First" movement (6), which is gradually spreading throughout the more important industries in various countries. It makes an appeal specially to the intelligence of the workmen. Factory managers are naturally concerned in the reduction of the accident rate, but, apart from all question of heavy compensation, where the law of the particular country specifically provides for it, they recognize how much work can be seriously hampered by preventable accidents. The best course to pursue is to start a vigorous "Safety First" campaign, and at the same time to maintain a careful record of accidents in the factory.

The employer, the writer has found, frequently objects to starting a system of record-keeping on the ground of expense. Enough has been said to show that any money spent in this direction will bring a high return in efficiency and consequently in output. Factory managers in England who have adopted a sound system of record-keeping readily testify to the truth of this statement. On the other hand the workers may object to what may seem at first sight to be inquisitorial enquiries. It ought not to be difficult, however, for a sympathetic manager to explain to his workers that the new system is really designed for their benefit. Furthermore, the many difficulties under which labour often struggles inarticulately should come to light if the records are utilized carefully and systematically. At present, in a great many cases, practically the only action that a worker takes, if he is unable to adapt himself to factory conditions, is to leave the factory. A study of the reasons of leaving, if recorded, should give the employer some insight into features found unsatisfactory by the workers, and he would then be in a position to eliminate or to reduce them.

Regarding the form in which the records should be maintained, the writer suggests that, at the outset, they should be as simple as possible. Later, they can be elaborated if necessary. The forms appended to this article are based on those published by the Industrial Fatigue Research Board in England (5, Appendix II). They have, however, been modified and simplified in such a way as to make them suitable for use in Indian factories.

To obtain all the necessary details regarding engagement and dismissal, a simple employment form kept on a card (see Form 1) is all that is required. When an estimate of the labour turn-over has to be made, all the relevant facts can be easily extracted from these cards. This information should then be summarized in tabular form (Form 2).

Lost time may be compiled for each individual, or, if this involves too much clerical labour, departmental returns may at first

suffice. In any case the form kept, whether for the individual or the department, does not differ very much (see Forms 3 and 4).

For purposes of classification of cases of sickness the medical officer will find it necessary to adopt some system. One that was found useful by the Ministry of Munitions is to be found in Report No. 13 of the Industrial Fatigue Research Board to which reference has already been made, and also at the foot of the sickness table (see Form 5). This, again, may be kept separately for each individual or may be maintained departmentally (see Form 6). Its utility will be much greater if arrangements can be made for a separate card to be kept for each individual.

With regard to accidents, experience has shown in England (7) that some individuals are more liable to accidents than others employed on exactly the same work. It is, therefore, obviously advantageous to keep, if possible, individual accident records. Similarly some departments have a higher accident rate than others. The individual records should, therefore, be summarized departmentally from time to time in tabular form. In accordance with rules framed under the Indian Factories Act and the Indian Mines Act, managers already have to submit accident reports. Much additional labour will not therefore be involved. The writer has attempted to give a model form which will be in conformity with existing regulations (see Form 7).

The writer will be very glad to answer any inquiries from interested readers.

It will also be very helpful if firms who already have experience in this matter will kindly communicate their views either to the writer or to the Editor of this JOURNAL.

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2. Three Studies in Vocational Selection. Indust. Fatigue Research Board, Rep. No. 16. London, H. M. Stationery Office, 1922.
3. Münsterberg, H.: Psychology and Industrial Efficiency. New York, Houghton Mifflin Co., 1913.
4. Kelly, R. W.: Hiring the Worker. New York, The Engineering Magazine Co., 1918.
5. Broughton, G. M., Newbold, E. M., and Allen, E. C.: A Statistical Study of Labour Turnover in Munition and Other Factories. Indust. Fatigue Research Board, Rep. No. 13. London, H. M. Stationery Office, 1921.
6. Various Publications of British Safety First Association, Savoy Street, Strand, London.
7. Greenwood, M., and Woods, H. M.: A Report on the Incidence of Industrial Accidents upon Individuals with Special Reference to Multiple Accidents. Indust. Fatigue Research Board, Rep. No. 4. London, H. M. Stationery Office, 1919.

RECORD FORMS

FORM 1.—EMPLOYMENT CARD*

Name	Sex	Caste	District of Domicile	Other Circumstances
Address				
Names of near relatives in factory	Age			

Date of Engagement	Department	Rate of Pay	Date of Leaving	Reason
	Job			

*This form is most conveniently kept in the shape of a folder, all the other records relating to the same individual can then be placed in it. In cases where men return after having left, some factories may find it desirable to enter the new particulars on the same card. This can be done if, in printing, sufficient space is left in the lower portion of the card.

FORM 2.—LABOUR TURNOVER

Month	Total Nos. Employed	Total Nos. Leaving	Left of Own Accord: Ill Health	Left of Own Accord: Dissatisfied	Left of Own Accord: Leaving District	Left of Own Accord: Other Reasons	Discharged: Ill Health	Discharged: Unsatisfactory	Discharged: Incompetent	Discharged: Reduction of Staff	Percentage Rate of Loss
January											
February											
March											
April											
May											
June											
Total											
July											
August											
September											
October											
November											
December											
Total											
Year											
Total											

FORM 3.—EMPLOYEES' ATTENDANCE REGISTER*

Name of factory............... *Month*............ *Year*.........

Department:..*Nos. employed during month*... *Total hours worked*.... { (a) *Ordinary*.. (b) *Overtime*.. } *Total hrs. lost*...... { (a) *Personal reasons* (b) *Sickness*....... }

Name	Age	Sex	Caste	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Jan Muhammad	29	M.	Muhdn	F	F	F	FO	H	A	½	F	F	FO_2	FO_4	FO_2	½	S	S	S	S	S	H	½	F	F	F	F	F	F	H				

*F=full day's work or actual number of hours. A=absent. S=absent sick: if due to accident mark SA. ½, etc. proportion of full day's work. F+O=full day + overtime. FO_2, etc.=2 hours of overtime. H=holiday.

FORM 4.—MONTHLY RETURN OF TIME LOST*

Name of factory *Total no. of employees*

Name of department *Total no. of hours worked* *Year*

Month	Total Number of Hours Lost				Total Time Lost	Total Possible Time	Percentage of Time Lost
	Illness	Accident	Personal Reasons	Other Reasons			
January . .							
February . .							
March . . .							
April . . .							
May . . .							
June . .							
July . . .							
August . . .							
September . .							
October . .							
November . .							
December . .							

*This is summarized from the departmental returns.

FORM 5.—DISPENSARY RECORD*

Name of factory

Medical record, 1922

Name of Worker	Age	Sex	Caste	Date off Duty	Date of Return to Duty	Occupation and No. of Room	Cause of Disability	Treatment Given
Jan Muhammad	29	M	Muhdn.	Jan. 14, 1922	Jan. 20, 1922	Spinner No. 1 room	Whitlow following injury to finger at work.	

*For purposes of quick tabulation the "Cause of Disability" may be summarized as follows. The exact diagnosis should be entered under the appropriate heading: (1) respiratory tract; (2) digestive tract; (3) circulatory system; (4) central nervous system; (5) special sense organs; (6) locomotive system; (7) skin; (8) influenza; (9) malaria and other fevers; (10) infectious diseases; (11) various; (12) accident and septic cases. For suggestions for filling in the diagnosis see Form 6.

FORM 6.—MONTHLY RETURN OF SICKNESS CASES REPORTED IN DISPENSARY*

A. Men
B. Women
C. Children

Month	Nos. Employed	Respiratory Tract	Digestive Tract	Circulatory System	Central Nervous System	Special Sense Organs	Locomotive System	Skin	Influenza	Malaria and Other Fevers	Infectious Diseases	Various	Accident and Septic Cases	Total No. of Sickness Cases	Percentage Rate of Sickness
January															
February															
March															
April															
May															
June															
July															
August															
September															
October															
November															
December															

*The exact diagnosis should be entered under the appropriate heading. As suggestions for filling in a diagnosis in the appropriate category, the following examples are given: (1) Respiratory tract, *e.g.*, bronchitis, pulmonary tuberculosis, pneumonia, adenoids. (2) Digestive tract, *e.g.*, indigestion, tonsillitis, appendicitis, diarrhoea, colitis, gastric ulcer, gastric carcinoma, dysentery. (3) Circulatory system, *e.g.*, anaemia, morbus cordis, angina pectoris, varicose veins. (4) Central nervous system, *e.g.*, debility, tabes, neurasthenia. (5) Special sense organs, *e.g.*, astigmatism, cataract, otorrhoea. (6) Locomotive system, *e.g.*, rheumatism, sciatica, lumbago, chronic arthritis. (7) Skin, *e.g.*, scabies, industrial dermatitis. (8) Infectious diseases, such as cholera, small pox, plague. (9) Various, *e.g.*, nephritis, measles, salpingitis, lead poisoning.

FORM 7.—EMPLOYEE'S ACCIDENT RECORD*

1. Branch of department in which accident occurred . . . .
2. Name of injured person. . . . . .Check No. . . . .
   Address. . . . .
   (*a*) Sex . (*b*) Age . (*c*) Caste (*d*) Occupation. .
3. Date and hour of accident. . . . .
4. Hour at which employee started work on day of accident. . . . .
5. Cause of accident. . . . .
   If caused by machinery:
   (1) Give name of machine and part causing accident . . . .
   (2) State whether it was moved by mechanical power at the time. . . . .
6. State exactly what injured person was doing at the time. . . . .
7. Describe fully nature and extent of injuries (*i.e.*, part affected). . . . .
8. Suggestions for prevention of similar accidents . . . .
9. Witness's name . . . . No. . . . .
10. Foreman . . . .
11. First aid by. . . . .
12. Other treatment by. . . . .

*Heads 2, 3, 5, 7, and 12 are required to be kept under Section 37 of the Indian Factories Act, 1911.

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE PRINCIPLES AND PRACTICE OF NURSING. By *Bertha Harmer*, B.Sc. (Columbia University), R. N. Instructor of Theory and Associate Instructor of Practical Nursing, St. Luke's Hospital Training School for Nurses, New York: Formerly Instructor of Theory and of Practical Nursing, and Supervisor of Nurses, The Toronto General Hospital Training School for Nurses, Toronto, Canada. Cloth. Pp. 695 with preface, table of contents and index. New York: The Macmillan Company, 1922.

OBSTETRICAL NURSING. By *Carolyn Conant Van Blarcom*, R.N. Formerly Assistant Superintendent and Instructor in Obstetrical Nursing and the Care of Infants and Children at the Johns Hopkins Hospital Training School for Nurses: Author of "The Midwife in England." Cloth. Pp. 558 with table of contents, illustrations, charts and index. New York: The Macmillan Company, 1922.

NEW GROWTHS AND CANCER. By *Simeon B. Wolbach*, M.D., Shattuck Professor of Pathological Anatomy in Harvard University. Cloth. Pp. 53 with illustrations. Cambridge: Harvard University Press, 1922.

X-RAY DOSAGE IN TREATMENT AND RADIOGRAPHY. By *William Daniel Witherbee*, M.D., Radiotherapist Presbyterian Hospital, New York; formerly Roentgenologist Rockefeller Institute; and *John Remer*, M.D., Radiotherapist New York Hospital, New York; Consulting Radiotherapist United Hospital, Port Chester. Cloth. Pp. 87 with preface, New York: The Macmillan Company, 1922.

JOINT MEETINGS OF INDUSTRIAL HYGIENE SECTION OF THE AMERICAN PUBLIC HEALTH ASSOCIATION AND THE OHIO ASSOCIATION OF INDUSTRIAL PHYSICIANS

CLEVELAND, OHIO, OCTOBER 17 AND 18, 1922

Program

Tuesday, October 17—9:30 A. M.

Hotel Statler

1. Business Meeting of Ohio Association of Industrial Physicians.

2. PRESIDENT'S ADDRESS. *Sydney S. McCurdy, M.D.*

3. CAUSES OF ABSENTEEISM AMONG STORE WORKERS. *Charles A. Swan, M.D.*, Medical Director, Halle Brothers Company, Cleveland, Ohio.

Discussion by *A. B. Emmons, 2d, M.D.*, Executive Secretary, Harvard Mercantile Health Work, Boston, Mass.

4. COMPUTATION OF PARTIAL LOSS OF VISION AND HEARING. *William M. Mehl, M.D.*, Buffalo, N. Y.

Discussion by *Webb P. Chamberlain, M.D.*, Cleveland, Ohio.

5. MENTAL HYGIENE IN INDUSTRY. *Frederick W. Dershimer, M.D.*, National Lamp Works, Cleveland, Ohio.

Discussion by *A. G. Cranch, M.D.*, Medical Director, National Carbon Company, Cleveland, Ohio.

6. HEAT HAZARDS IN INDUSTRY. *G. H. McKinstry, M.D.*, Medical Director, Spang, Chalfant & Company, Pittsburgh, Pa.

Discussion by *S. H. Johnson, M.D.*, Carnegie Steel Company, Pittsburgh, Pa.

Wednesday, October 18, 9:30 A. M.

Nela Park, Laboratory of Applied Science, Room 117

1. Business Meeting of Industrial Hygiene Section, American Public Health Association.

2. The Tuberculosis Problem in Industry. (Stereopticon illustration.) *Horace John Howk, M.D.*, Assistant Medical Director, Metropolitan Life Insurance Company; Physician in Charge, Metropolitan Life Insurance Sanatorium, Mt. McGregor, N. Y.

Discussion by *H. A. Pattison, M.D.*, Supervisor, Medical Service, National Tuberculosis Association, New York City; *James A. Britton, M.D.*, International Harvester Company, Chicago, Ill.; and *George M. Price, M.D.*, Director, The Joint Board of Sanitary Control, New York City.

3. Industrial Dermatoses. (Stereopticon illustration.) *Harold N. Cole, M.D.*, Associate Professor of Dermatology, Western Reserve University, Cleveland, Ohio.

Discussion by *Charles Baskin*, Akron, Ohio.

4. Health Education in Industry. (Stereopticon and motion picture illustration.) *Ralph W. Elliott, M.D.*, Manager, Medical Department, National Lamp Works of General Electric Company, Cleveland, Ohio.

Wednesday Afternoon—2:30 P. M.

1. Lighting and Vision, with Special Emphasis on School-Lighting and Home-Lighting. (Followed by lighting demonstrations.) *M. Luckiesh*, Director of Applied Science, Nela Research Laboratories.

2. Industrial Lighting. (Followed by demonstrations.) *Ward Harrison*, Illuminating Engineer, National Lamp Works.

THE JOURNAL OF INDUSTRIAL HYGIENE

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A DISCUSSION OF THE METHOD OF A. D. WALLER FOR COMPUTING ENERGY OUTPUT, AND RESULTS OF EXPERIMENTS DETERMINING ENERGY EXPENDITURE DURING SOME HOUSEHOLD TASKS*

S. GAIRNS AND M. K. O'BRIEN

(From the Departments of Physiology and Food Chemistry of the University of Toronto)

DISCUSSION

A QUICK method of measuring the energy output during work has been suggested by A. D. Waller (1), in which the carbon dioxide expired during a short period of work is measured and its calorie equivalent calculated by assuming a constant respiratory quotient. The present investigation was undertaken partly to determine how far Waller's method is permissible for approximate work, and partly to secure data on the energy expenditure in various household duties.

Both the carbon dioxide output and the oxygen intake were measured, and from these values the respiratory quotient was calculated. By the use of Lusk's table the calories per hour per square meter of body surface were computed from the caloric equivalent per liter of oxygen corresponding to the respiratory quotient actually determined.

Waller contends that by the use of his shorter method a "fair" estimate can be made of various kinds of work not directly measurable in mechanical units. He contends that although an error of ± 5 per cent. is involved, his method is of value because so many more determinations can be made in less time than is required by the longer method, that the final results obtained, when taken together, are as accurate as those obtained by the longer method. He collected the expired air in rubber bags of 20 to 30 liters' capacity for periods of one-half to one minute, the bags being fitted with suitable tubing, valves, and three-way taps. Such collections of air were made at intervals of about one hour during the work. In order to save time no mask was used, but the subject breathed by mouth into the tubing, with a clip on his nose. The air was measured by a Verdin Spirometer, and the carbon dioxide estimated at once by potassium hydroxide absorption.

*Received for publication July 11, 1922.

The first results were those of a dock laborer laying a concrete floor (2). Hourly determinations were made of the carbon dioxide discharge for half a minute immediately after work and for half a minute after three minutes' rest. From the data obtained Waller learned that an efficient dock laborer, with a resting carbon dioxide output of 5 c.c. per second, did hard work at an average cost ranging during the day between 10 and 15 c.c. of carbon dioxide per second. The values determined from the samples taken after three minutes' rest were from 30 to 40 per cent. lower than those from the samples taken immediately after the work ceased. To obtain the carbon dioxide value for a known amount of work, the subject (83 kilos in weight) made ten ascents of a 20 meter staircase, the expired air being collected for the last 10 meters of each ascent. The rate of doing the staircase work was 21.6 kg.m. per second, and the carbon dioxide output averaged 25.8 c.c. per second. As the carbon dioxide output at rest was 5 c.c. per second, the cost of doing 21.6 kg.m. of staircase work was 20.8 c.c. of carbon dioxide—*i.e.*, 1 kg.m. costs 0.96 c.c. of carbon dioxide. The cost of dock laboring averaged from 10 to 15 c.c. of carbon dioxide per second, so that the mechanical value of the work was at the rate of 10.4 to 15.6 kg.m. per second.

$$\frac{10 \text{ c.c. per second}}{0.96 \text{ c.c. } CO_2 \text{ per kg.m.}} = 10.4 \text{ kg.m. per second.}$$

Comparisons were also made of the cost of piece-work with that of time-work, by means of the carbon dioxide output in dock laborers (3). Averaging the last three hours of two complete days of each type of work, and allowing 4 c.c. per second for carbon dioxide output at rest, the cost of piece-work was found to be 20.2 c.c. of carbon dioxide per second and the cost of time-work 13.4 c.c. of carbon dioxide per second. Assuming a respiratory quotient of 0.84, for which the caloric equivalent of 1 c.c. of carbon dioxide=5.91 calories, these amounts represent 430 calories per hour for piece-work, and 284 calories per hour for time-work.

It may be well to mention here that Waller did not obtain the carbon dioxide value at rest by an actual experiment, but by allowing 1 c.c. of carbon dioxide for every 20 kg. of body-weight. In these experiments the samples were not collected during the working period, but for half a minute immediately after the work. To justify this procedure Waller determined the carbon dioxide discharge at regular half-minute intervals during and after a short piece of staircase work (1410 kg.m. in fifty-two seconds) (4). At the end of the first 10 meters the carbon dioxide discharge was 28.2 c.c. per second; at the end of the second 10 meters, 33.3 c.c. per second; and at the end of the first one-half minute of rest, 36.7 c.c. per second. The carbon dioxide value then fell, reaching the normal level in about ten minutes. From this result he concluded that since the maximum carbon dioxide discharge occurred during the first half-minute of repose, he was justified in taking his samples immediately after the work ceased.

Another experiment was made "to determine the physiological cost of marching measured by CO_2" (5). The mechanical efficiency of the subjects was estimated as before by staircase work. The marching was performed at different rates and, as was to be expected, the carbon dioxide output per second increased as the rate increased. When the subject was marching at the rate of 4 miles per hour the carbon dioxide discharge per second was 17.0 c.c.; when he

was marching at the rate of 7 to 8 miles per hour it was 51.8 c.c. From this and other experiments Waller found that the cost of horizontal walking was 0.1 c.c. of carbon dioxide per kilogram of body-weight per horizontal meter, as represented by the following equation:

$$\frac{CO_2}{\text{kg.m.}} = 0.1$$

Observations were also made with the ergometer but these will not be considered here. The efficiency of staircase work was found to be about double that of bicycle work when the rate of the former was twice that of the latter. The observations on tailors (6) and printers (7) doing various types of work are particularly interesting.

Experimental Work

Apparatus Used.—A Douglas bag was used to collect the expired air and it was shown that there was no diffusion of carbon dioxide through the bag within one and a half to two hours. The bag was connected by rubber tubing to a face mask (8, p. 590) (9), which was fitted with Douglas (mica) valves. The mask was tested for leaks before each experiment. A specially calibrated Newcomer meter (10) was used to measure the volume of air collected. The expired air was analyzed in a Haldane gas analysis apparatus.

Rest Experiments

In order to obtain the increase in energy output due to work alone, it was necessary to establish a base-line which was determined for each subject by a rest experiment before each work experiment.

The subjects were allowed to rest for ten or fifteen minutes in the laboratory before the mask was adjusted, and then for some time the expired air was caused to pass out to the atmosphere through the three-way tap. After equilibrium of respiration had been established, the three-way tap was turned so that the expired air entered the bag. The subject breathed quietly for five or ten minutes, then the tap was turned off, and the bag disconnected from the mask. The gas in the bag was thoroughly mixed so that all parts would be well washed out with the expired air, and this sample was then discarded. After the bag had been thoroughly emptied, it was reconnected and the subject breathed into it for ten or fifteen minutes. The gas was then well mixed and about one-half of it was passed through the meter. The temperature of the expired air was registered by a thermometer fitted into the inlet tube of the meter.

Before a sample was taken for analysis the bag was again thoroughly kneaded. Samples were transferred to the gas analysis apparatus by a 30 c.c. syringe, with the usual precautions to avoid errors due to dead space. All analyses were made in duplicate.

The respiratory quotient was determined from the values found for carbon dioxide and oxygen. Lusk's table (8, p. 598) (11, p. 75) for the caloric equivalent of oxygen at varying respiratory quotients was used to compute the total calories, and from this value the calories per hour per square meter of body surface were deduced.

Experiments to Check Waller's Work

Period of Collection of Sample.—In order to shorten the time required to determine the energy output, Waller collected the samples of expired air during periods of one-half minute. In order to determine what error this method might involve, we collected the expired air dur-

ing (1) one-minute periods and (2) five-minute periods. A comparison of the carbon dioxide output per second and the oxygen output per second, and the respiratory quotients for both periods are shown in Table 1. The one-minute samples were collected immediately after the five-minute samples except in the last three experiments of Table 1, and in these the five-minute samples were taken after the one-minute samples.

TABLE 1.—COMPARISON OF CARBON DIOXIDE AND OXYGEN OUTPUTS PER SECOND DURING ONE-MINUTE AND FIVE-MINUTE PERIODS, AND RESPIRATORY QUOTIENTS FOR BOTH PERIODS

One-Minute Samples				Five-Minute Samples		
CO_2 per Sec.	O_2 per Sec.	R. Q.	Condition	CO_2 per Sec.	O_2 per Sec.	R. Q.
3.80	4.30	0.903	Rest	3.09	3.54	0.874
3.02	3.51	0.860	"	3.91	3.56	0.876
2.97	3.06	0.970	"	3.36	3.68	0.913
8.43	9.28	0.908	Floor-polishing	9.53	10.34	0.915
3.27	3.69	0.888	Machine	4.02	4.55	0.883
6.73	7.35	0.915	"	6.00	6.76	0.887
6.11	7.33	0.830	"	5.42	6.53	0.831
5.58	5.93	0.940	"	3.82	4.26	0.863
4.16	4.94	0.842	"	4.02	4.05	0.883
4.05	5.46	0.742	Floor-polishing	14.21	14.70	0.957
5.62	7.54	0.745	"	10.19	11.26	0.905

The results show a marked variation in the two periods. In some experiments the amounts of carbon dioxide and oxygen are greater in the one-minute samples; in others they are greater in the five-minute samples. The variations are much too marked to say that the sample of the shorter period is representative of the composition of the expired air. Undoubtedly Waller's method would be still less reliable because in a half-minute period the error caused by turning the tap of the bag at different phases of respiration would be greater than in a one-minute period. Waller's shortened method sacrifices too much accuracy for the sake of speed, and this sacrifice we feel is not justifiable.

Samples at Beginning of Work.—In a number of his experiments Waller collected the half minute sample as soon as work began. We performed a few experiments in which the expired air was collected as soon as work began, and compared the results with samples collected (*a*) during a later period of work, and (*b*) during a period of rest preceding the work.

In Table 2 the first two experiments show less carbon dioxide, oxygen and calories per minute, also a lower respiratory quotient for the first minute of work than for a later period of work. In the third experiment the results are much closer for the two periods. All experiments show a lower respiratory quotient during the first minute of work than during the period of rest. In a similar series of experiments Orr and Kinloch (12) obtained the same result.

Samples after Work.—In other experiments Waller collected the samples as soon as the work ceased. In the experiment with the dock laborer he found that the carbon dioxide output fell 30 to 40 per cent. during the first three minutes after the work ceased. This result led us to believe that the fall in carbon dioxide output began immediately after the work was finished. In a few of our experiments in which the expired air was collected during one minute, three minutes after the work ceased we obtained results agreeing with those of Waller. The fall in carbon dioxide output in our experiments varied from 24 to 36 per cent. (see Table 3). In other experi-

ments we collected the expired air during the first minute after work ceased. The results (see Table 4) confirmed our belief that a fall in carbon dioxide output occurs immediately on the cessation of work.

From the results given in Tables 2, 3, and 4, it is evident that Waller's method of collecting the sample at the beginning of work, or immediately after the work ceased, is quite inaccurate.

Assumed Respiratory Quotient vs. Determined Respiratory Quotient. — The respiratory quotient in our experiments varied from 0.78 to 1.04, so that considerable error would be involved by assuming, as Waller did, a respiratory quotient of 0.85 for all observations. Table 5 gives the results of our experiments in which the calories per square meter of body surface are computed (1) from oxygen at varying respiratory quotients, and (2) from carbon dioxide at a constant respiratory quotient of 0.85. Comparing the results in Table 5, it will be noticed that the variation in the last two columns is least when the respiratory quotient actually determined is closest to the respiratory quotient of 0.85 assumed by Waller. The variation in the two methods is even more evident in a short series of experiments in which the same subject did the same piece of work on two days. The results are computed as before (1) from oxygen at varying respiratory quotients, and (2) from carbon dioxide at a constant respiratory quotient. It will be seen from Table 6 that the variation in the calorie output for the two days is always greater when the results are computed according to Waller's method. This table shows that in these experiments the method of calculating from oxygen is 10 to 11 per cent. more accurate than Waller's method.

TABLE 2.—COMPARISON OF SAMPLES OF EXPIRED AIR COLLECTED DURING REST PRECEDING WORK, AT BEGINNING OF WORK, AND DURING A LATER PERIOD OF WORK

Experiment	Period	CO_2 per Min.	O_2 per Min.	R. Q.	Cal. per Min.
1	Rest	194.46	228.08	0.852	1.11
	1st min. of work	243.23	327.53	0.742	1.55
	3-8 min. of work	851.47	882.92	0.957	4.40
2	Rest	175.47	215.20	0.815	1.034
	1st min. of work	337.43	452.94	0.745	2.141
	3-8 min. of work	611.56	675.54	0.905	3.333
3	Rest	212.17	226.00	0.938	1.12
	1st min. of work	249.87	296.43	0.842	1.43
	16-26 min. of work	241.21	273.16	0.883	1.34
	1st min. *after* work	196.54	221.34	0.888	1.08

TABLE 3.—FALL IN CARBON DIOXIDE OUTPUT THREE MINUTES AFTER WORK

Work	Per Cent. CO_2 during Work	Per Cent. CO_2 3 Min. after Work	Per Cent. Fall in CO_2
Staircase	4.25	3.10	27.15
Machining	2.90	1.85	36.20
Ergometer	3.95	3.00	24.05

TABLE 4.—FALL IN CARBON DIOXIDE OUTPUT IMMEDIATELY AFTER WORK

Work	Per Cent. CO_2 during Work	Per Cent. CO_2 after Work	Per Cent. Fall in CO_2
Staircase	4.35	3.80	12.60
Machining	3.50	3.05	12.80
Floor-polishing	3.70	3.40	8.11

Efficiency Experiments

In order to determine the efficiency of a subject it is necessary that a known amount of work should be done. For this purpose two types of experiments were performed: (1) staircase, and (2) ergometer.

Staircase Experiments.—As far as possible Waller's method was followed (*i.e.*, collecting the sample of expired air during the last half of each ascent, and calculating the efficiency from carbon dioxide). A metronome was used to keep the rate of walking constant. The work done was five ascents of a 10-meter staircase, but the tap was turned to the bag only during the last half of each ascent—*i.e.*, the sample was collected during five ascents of 5 meters. The caloric value of the work done was determined by using the value, 1 calorie=425 kg.m. The cost of work in calories was obtained by subtracting from the caloric expenditure during work the caloric expenditure during rest for the same period. The ratio

$$\frac{\text{work}}{\text{cost}} \times 100 = \%\ \text{efficiency.}$$

Ergometer Experiments.—A bicycle ergometer (13) was used, the work done being measured by the number of revolutions of the wheel per minute × the circumference of the wheel × frictional pull. The subjects used different rates, but the rate for each experiment was kept constant during the preliminary period of three minutes, and during the experimental period of five minutes.

Table 7 gives a comparison of our ergometer and staircase experiments. The calculations were made according to Waller's method—*i.e.*,

$$\frac{\text{work}}{\text{cost}} = \frac{\text{kg.m. per second}}{\text{net } CO_2 \text{ per second}}.$$

The results agree with his. Results (1), (2), and (3) in the ergometer table represent the work done at three rates—60, 84, and 104 steps per minute, respectively. They show that as the rate of work increases the ratio $\frac{\text{work}}{\text{cost}}$ increases—*i.e.*, efficiency increases. Comparing (4) in the ergometer table with (1) in the staircase table, it is seen that work done on the staircase at twice the rate of the work done on the ergometer (10.04 kg.m. per second vs. 5.5 kg.m. per second), gives a higher $\frac{\text{work}}{\text{cost}}$ ratio; (5) and (6) in the ergometer table compared with (2) in the staircase table show the same result. If (7) in the ergometer table is compared with (1) in the staircase table, it is seen that when the rate of work on the staircase and on the ergometer is the same, the efficiency in doing staircase work is again higher.

Table 8 gives our results for staircase and ergometer experiments computed by Benedict's method.[1] The experiments are in the same order as in Table 7. Table 8 includes two additional experiments in both types of work. From (1), (2), and (3) it is seen that the efficiency increases as the rate of work on the ergometer increases (this is shown in column $\frac{a}{b-c} \times 100$). Comparing the ergometer table with the staircase table, it is seen that when the calorie value of the work done is approximately equal for both kinds of work, the efficiency in doing the latter is always greater than the efficiency in doing the former. If (4) in the ergometer table is compared with (2) in the stair-

[1]Benedict's method (11, p. 112) of computing the net efficiency of a subject is as follows:

$$\text{Net efficiency} = \frac{\text{Heat equivalent of muscular work done}}{\text{Increase in energy due to work}}$$

$$= \frac{a}{b-c} \times 100$$

a = heat equivalent of work done (1 calorie = 425 kilogrammeters).
b = total caloric output for period of work.
c = resting requirement in calories for similar period.

TABLE 5.—RESULTS OF EXPERIMENTS IN WHICH CALORIC OUTPUT WAS COMPUTED FROM OXYGEN AT VARYING RESPIRATORY QUOTIENTS, AND FROM CARBON DIOXIDE AT A CONSTANT RESPIRATORY QUOTIENT

Work	Net CO_2 per Sec.	Net O_2 per Sec.	R.Q.	Cal. per Hr. per Sq. M. from O_2	Cal. per Hr. per Sq. M. from CO_2 (R.Q. 0.85)
Bread-making	2.37	1.17	1.000	14.44	33.30
	3.65	3.48	1.040	42.42	55.07
	1.90	2.56	0.836	27.09	21.29
	4.07	4.80	0.896	56.38	57.25
	3.48	3.77	0.918	49.60	54.39
	1.95	2.11	0.875	22.23	27.43
	1.41	1.53	0.940	16.24	17.71
Machining	3.71	1.05	0.807	10.94	9.36
	2.95	2.76	1.020	35.66	44.46
	0.48	0.78	0.883	8.68	6.80
	2.06	2.84	0.831	30.19	27.17
	0.32	0.40	0.895	4.64	4.51
	1.00	1.28	0.863	13.45	12.57
Floor-polishing	1.08	1.48	0.882	16.29	14.24
	6.44	6.80	0.915	76.57	84.92
	1.66	2.14	0.869	26.22	25.02
	10.95	10.91	0.957	123.27	144.40
	7.26	7.67	0.905	85.99	95.74
	5.73	6.19	0.910	68.90	75.56

TABLE 6.—VARIATION IN CALORIC OUTPUT DURING TWO DAYS' WORK COMPUTED FROM OXYGEN AT VARYING RESPIRATORY QUOTIENTS, AND FROM CARBON DIOXIDE AT A CONSTANT RESPIRATORY QUOTIENT

Work	CO_2 per Sec.	O_2 per Sec.	R.Q.	Cal. per Hr. per Sq. M. from O_2	Cal. per Hr. per Sq. M. from CO_2 (R.Q. 0.85)	Variation in 2 Days' Work O_2 Method %	Variation in 2 Days' Work CO_2 Method %
Machining	2.45	2.85	0.887	31.72	32.31	5.0	16.0
	2.06	2.84	0.837	30.19	27.17		
Walking	6.53	8.28	0.835	90.43	86.11	6.4	16.5
	7.61	8.79	0.876	96.24	100.35		
Floor-polishing	7.03	8.51	0.825	92.43	92.71	25.0	36.0
	10.95	10.91	0.957	123.27	144.40		

TABLE 7.—COMPARISON OF RESULTS OF ERGOMETER AND STAIRCASE EXPERIMENTS COMPUTED BY WALLER'S METHOD

Ergometer Kg.M. per Sec.	Ergometer Net CO_2 per Sec.	Ergometer $\frac{\text{Kg.M.}}{CO_2}$	Staircase Kg.M. per Sec.	Staircase Net CO_2 per Sec.	Staircase $\frac{\text{Kg.M.}}{CO_2}$
(1) 9.90	13.66	0.724			
(2) 13.86	13.21	1.040			
(3) 17.16	11.80	1.450			
(4) 5.54	11.59	0.478	(1) 10.04	8.85	1.13
(5) 6.60	12.23	0.543	(2) 13.90	12.64	1.09
(6) 6.60	11.47	0.575	(3) 19.06	17.13	1.11
(7) 10.56	12.91	0.817			

TABLE 8.—COMPARISON OF RESULTS OF ERGOMETER AND STAIRCASE EXPERIMENTS COMPUTED BY BENEDICT'S METHOD

	Ergometer a	Ergometer b	Ergometer c	Ergometer $\frac{a}{b-c} \times 100$		Staircase a	Staircase b	Staircase c	Staircase $\frac{a}{b-c} \times 100$
(1)	4.19	18.12	3.51	28.67					
(2)	5.87	16.00	3.24	46.00					
(3)	7.26	13.48	3.57	72.25					
(4)	1.56	9.34	2.06	21.42	(1)	1.06	2.82	0.92	55.79
(5)	4.66	24.63	4.76	23.45	(2)	2.94	5.66	1.86	77.37
(6)	4.66	23.64	6.18	26.69	(3)	4.03	7.10	1.92	77.79
(7)	4.47	14.23	3.09	40.12	(4)	4.03	8.35	2.47	68.53
(8)	4.80	13.26	3.09	47.19	(5)	1.27	2.78	0.54	56.69
(9)	2.60	14.96	2.06	20.23					

case table, it is seen that the efficiency in performing staircase work is also higher even when the caloric value of the work done is approximately twice that of the work done on the ergometer. These results agree with those obtained by Waller's method, but Benedict's method is considered much more accurate since it involves the use of the determined caloric output and not merely the use of the carbon dioxide determination.

TABLE 9.—RESULTS FOR HORIZONTAL WALKING EXPERIMENT COMPUTED BY WALLER'S METHOD

	Kg.M. per Sec.	Net CO_2 per Sec.	$\frac{CO_2}{Kg.M.}$
(1)	64.81	6.95	0.107
(2)	82.69	7.61	0.092
(3)	83.35	6.53	0.078
(4)	67.54	6.90	0.102
(5)	67.53	6.06	0.089

Horizontal Walking Experiments.—The subjects walked a distance of 700 meters at a uniform rate. In order to check Waller's method the work done was calculated by the distance in meters × the body-weight in kilos. It was also determined by measuring the total caloric output, as recommended by Benedict (14).

In Table 9 our results for the horizontal walking experiment have been computed by Waller's method. In Table 10 the results have been computed by Benedict's method without taking into account, however, the energy expenditure due to the lifting of the body-weight at each step.

By comparing the last column in Tables 9 and 10 it is seen that the cost of horizontal walking, either in cubic centimeters of carbon dioxide per kilogrammeter, or in gram calories per kilogrammeter, does not agree with Waller's conclusion that the $\frac{\text{cost}}{\text{work}}$ ratio is a constant (0.1). In both tables numbers (2) and (3), and (4) and (5) are, respectively, the results of a subject doing the same amount of work at approximately the same rate. It will be seen that the cost of work is not constant even for the same individual, and that Waller was not correct in claiming that there is an increase of 0.1 c.c. of carbon dioxide per kilogram per horizontal meter.

TABLE 10.—RESULTS FOR HORIZONTAL WALKING EXPERIMENT COMPUTED BY BENEDICT'S METHOD

					Heat Output Increase over Sitting	
	Body-Wt. (Clothed+Bag)	Distance per Min.	Horizontal Kg.M. per Min.	Total Cal. per Min.	Total Cal. per Min.	Per Kg.M. in Gm.=Cal.
(1)	50.00	77.77	3888.88	3.31	2.43	0.625
(2)	64.30	77.14	4960.20	3.73	2.56	0.516
(3)	64.30	77.77	5001.11	3.55	2.41	0.481
(4)	46.31	87.50	4652.12	3.59	2.48	0.612
(5)	46.31	87.50	4052.12	2.32	2.18	0.537

Energy Expenditure during Some Household Tasks.—The household tasks which were performed to obtain data were bread making, machining, and floor-polishing. The results of the energy expenditure during these tasks are of interest.

In the bread-making experiments the cost in calories per hour per square meter varied from 14.44 to 56.38 calories. The average cost for eight experiments was 33.53 calories, with an average variation of ±13.52 calories. Every experiment was done by a different subject.

The rate of machining varied from 52 treads per minute to 124 per minute,

and the energy expenditure varied accordingly, being 4.64 calories when the rate was 52 treads, and 30.95 calories when the rate was 124. In ten experiments the cost per hour per square meter averaged 16.05 calories, and the average variation was ±9.72 calories.

The floor-polishing experiments were done at rates which varied from 30 to 75 strokes per minute. The cost per hour per square meter at the rate of 30 strokes was 11.98 calories, and at the rate of 75, 68.9 calories. The length of the stroke for the experiments at the rate of 50 strokes was double that used in all other experiments, and as a result the cost at that rate was even higher than at the faster rates. Averaging all the experiments (eleven), the cost in calories per hour per square meter was 48.86 calories, the average variation being 25.06 calories.

Conclusion

From these results it seems fair to conclude that Waller's method of computing the energy output from the carbon dioxide expired would be useful in saving time, but it does not give accurate results, and is therefore unsatisfactory. The short periods which he used for collecting the samples of the expired air, and the method of collecting the samples at the beginning of the work and after the work was finished, all involved serious error. It is also evident from our results that it is essential actually to determine the respiratory quotient in all experiments, and to compute the energy output by means of the calorie equivalent of oxygen for the quotient obtained.

Waller's method of ascertaining the efficiency of the subject is also considered inaccurate because it is not based on the caloric output.

In conclusion, we feel that Waller's short method of computing the energy output is of little value, since it disregards so many factors essential for accurate determinations.

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THE USE OF THE SPOT MAP IN THE INDUSTRIAL DISPENSARY*

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FOR several years epidemiologists and sanitary engineers have used spot maps to help them analyze the health conditions in given communities. During the Salem, Ohio, typhoid epidemic of 882 cases,[1] the state epidemiologists had a map of the entire city prepared, showing the location of every house in the city. Whenever a case of typhoid developed, a colored tack was placed in the proper space on the map. Differently colored tacks were used to represent different weeks, so that not only the actual number and distribution of cases could be seen at a glance, but also the matter of contact infection could be easily checked.

We have borrowed this idea and have used it to aid us in keeping a daily check upon the health conditions in our plant. By means of the spot map a picture is constructed which enables one to visualize, almost at a glance, a situation which pages of written reports fail to make clear. This procedure has been of such value that we offer it for publication in the hope that others may benefit by it. It is, in fact, quite simple; all that is necessary is a floor plan of the factory showing the location of each operator and a set of six or eight differently colored tacks.

Modus Operandi

If an operator comes to the dispensary and is found to be suffering from tonsillitis, a red tack is at once placed upon the map in a position corresponding with her location in the factory. If her case is severe, the operators working near her are given a gargle. Meantime the map is watched closely to see whether other cases of tonsillitis develop in the same department.

A blue tack is used to denote a case of coryza, or nose cold; a green tack indicates bronchitis, a yellow one, contagious skin lesions such as scabies and impetigo; a brown and white plaid one, influenza or grip; and a red and black plaid one, enteritis. A green tack with a black cross (the cross drawn with pen and ink) denotes the absence of an employee on account of illness. If the nature of the illness is known, the tack denoting that particular disease is placed with the absentee tack. A red tack with a black dot in the center means an accident. It is surprising to see the number of tacks of this sort on the charts from some departments. This particular finding may aid the safety committee in reducing the number of accidents to a minimum.

One of the most valuable tacks is the pink one, which represents headache from all causes. On several occasions, by watching the increasing number of headache tacks in one department, we have discovered lack of attention to ventilation.

During the last grip epidemic we tried to send operators who were coming down with the disease away from the plant at the earliest possible moment. Prophylactic treatment (consisting of a gargle

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[1] Bunn, W. H.: The Salem, Ohio, Typhoid Epidemic: A Clinical Report. Jour. Am. Med. Assn., 1921, 76, 1159.

and nose pack of a camphor-menthol compound) was then given to all the employees who had been in contact with them. An effort was made to surround every grip tack on the board with a yellow cross tack (a yellow tack with a black cross drawn on it with ink stands for prophylactic treatment in this system). The ease with which contagious cases were kept in mind, and the faithful prophylactic work of the dispensary nurse, we believe, accounted for the low incidence of grip in our factory—an incidence much lower than that of some other institutions in this vicinity.

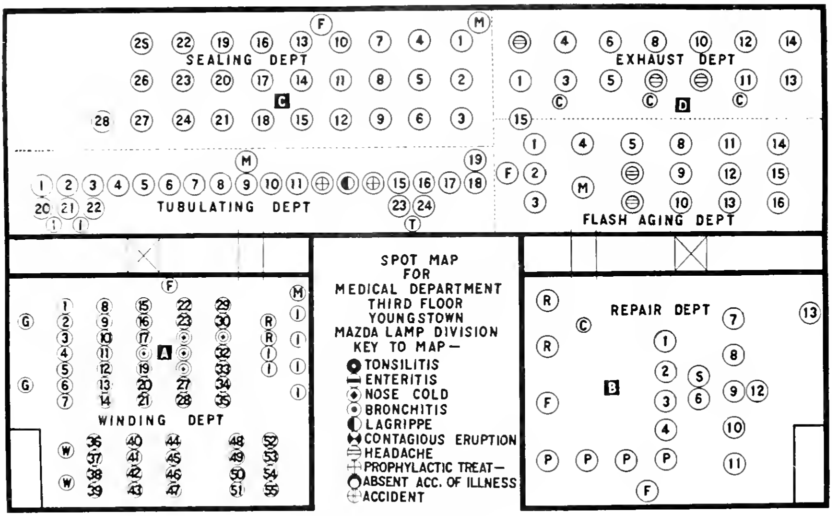

Fig. 1. Sample spot map.

In order to illustrate some of the uses of the map, the diagram shown in Figure 1 has been prepared. For convenience in photographing, however, designs have been substituted for colors.

It will be noted that in Department A there are several cases of coryza all grouped around a central one. This unusual situation shows just how infectious an acute nose cold can be. The condition would probably have been overlooked, had not the spot map been in use. The operator just opposite the letter A was the first to report. The adjoining operators developed nose colds within a few days.

In Department D there were several cases of headache on successive days. An investigation of this condition, which was first noted on the spot map, revealed the fact that the ventilating system was not functioning properly.

The grip and prophylactic tacks placed in Department C illustrate the method of trying to prevent the spread of disease by the use of prophylactic measures and the advantage of using the spot map for this purpose. Operator Number 13 developed grip, and operators 12 and 14 were given prophylactic treatment.

Removal Record

To prevent the tacks from accumulating on the board, a removal record, such as that shown in Figure 2, is used. This consists of a sheet of ruled paper on which is kept the serial number of the case, the date that the tack was placed on the board, the initial or number of the operator's machine, the color of the tack, and the date that the tack is to be removed. The tacks denoting contagious conditions are left on for a fourteen-day period. The headache and accident tacks are left on for one week.

No.	Date	Dept. No. and Initial	Color	Removed
211	2/10/22	A18—M. S.	Blue	2/24/22
212	2/11/22	D7 —S. I.	Pink	2/18/22

Fig. 2.—Tack removal record.

When the removal-record sheet is filled, a new one is attached to the map and the old one is filed. This constitutes a permanent record which can be used for statistical purposes at any time.

Summary

The spot map can be used to advantage in an industrial dispensary for the following reasons:

1. It visualizes the health situation.
2. It is of value in checking the spread of infectious diseases.
3. It supplies valuable accident information to the safety committee.
4. It makes a permanent record for statistical purposes.

A CLINICAL STUDY OF FUR CUTTERS AND FELT HAT WORKERS*

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ONE hundred and eight hatters' fur workers and felt hatters were examined in Danbury, Connecticut, in the autumn of 1921. Public announcement was made of the opportunity for medical examination, and all the workers who presented themselves were examined without selection. With few exceptions they were men actively engaged at their respective trades, and few of them considered themselves notably diseased.

For the purposes of this analysis of findings, the examination records of eight persons have been eliminated; six of them had been employed for less than two years, one was a young apprentice, and the record of another was incomplete. There are available, accordingly, the results of 100 fairly complete physical examinations. In addition, twenty-seven urine analyses were made, and subsequent to the examinations radiographs of the chests of fifty-six members of the group were obtained.

Representatives of thirty fur or hat shops were found among the 100 men, twenty-two of whom constituted the largest single shop contingent.

Occupation.—Eight men were hatters' fur workers, four of whom were engaged in carrotting, the others doing cutting, clipping, plucking or shaving. Sixty-nine worked in the "back shops" of hat makers' establishments, distributed among the following trade processes:

Blowing	1
Coning	6
Hardening	2
Starting	3
Sizing	48
Dyeing	1
Blocking	4
Pouncing	2
Napping	1
Velouring	1

Twenty-three were "front shop" finishers. Many of the men had been employed previously at other processes than those of their recorded occupations.

Nationality.—Of the 100 men, twenty-six were native born of native parentage. Fifty-seven were foreign born; of this number fifteen were born in Ireland, seventeen in Austria-Hungary, Czecho-Slovakia, or Poland, eight in Italy, seven in Syria, five in Germany, and five in other countries. Seventeen were native born of foreign parentage, for the greater part either Irish or Italian.

Age and Duration of Service.—The men ranged from 23 to 67 years of age, and had been employed in the hatting industry for periods varying from two to forty-seven years. They were distributed as follows with respect to age and to duration of service:

Age Distribution

Years	No.
20-29	18
30-39	36
40-49	23
50-59	13
60 and over	10

Distribution with Respect to Duration of Service

Years	No.
2 to 3	4
3 to 5	12

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Years	No.
5 to 10	12
10 to 15	13
15 to 20	20
20 to 25	15
25 to 30	4
More than 30	20

It may be noted that 72 per cent. of the group had been employed in the industry for more than ten years, 39 per cent. for more than twenty years, and 20 per cent. for more than thirty years.

Medical History.—Little information of value was secured regarding the medical histories of either the members of the group or of their families. Two instances of family tuberculosis were recorded, and several men had had typhoid fever or malaria. All but nineteen denied having had venereal disease. Of this number, one admitted having had syphilis.

Ninety of the group used tobacco, many of them in considerable amounts. Chewing was especially prevalent. Twenty-one stated that they had not drunk alcoholic beverages, but of the remaining seventy-nine many frankly admitted habitual excessive drinking. Fifty men drank coffee; ten drank tea.

Appearance.—The general appearance of most of the members of the group was good. Sixty-nine were rated as of good nutrition; twenty-five, fair; and six, poor. Few of the men were emaciated, and most of them were of approximately normal weight.

Skin.—The color of the skin was good in eighty-one of the men, and fair in seventeen. Two men were distinctly pallid. No hemoglobin determinations were made. Skin eruptions were negligible. There were observed among the sizers, however, deep indurated calluses of the hands extending from the thenar and hypothenar eminences over the palms and to the finger tips. In many instances the hands were stained by dyes used in the sizing kettles. Eighteen men, sixteen of them sizers, showed marked calluses of the type described. Six sizers had developed Dupuytren's contractions, usually of the little finger of one or both hands. A flanger and a curler had similar disabilities.

Special Senses.—According to the statements of the individuals examined, vision was highly deficient in but few instances. Forty of the men wore glasses, especially for reading. The pupillary reactions were not remarkable.

Partial deafness was recorded in eighteen cases, and a history of running ears in ten. Thirty-three persons complained of tinnitus, though few were affected constantly. There was no notable evidence of diminished olfactory sense.

Teeth.—The teeth of most members of the group were in fair condition. Twenty-eight men stated that they had occasional or frequent toothache. In but rare instances was there evidence of extensive dental disease with loosening of the teeth. Many men had lost several molars, five wore plates in both jaws, and three in one jaw only. Marked discoloration of the teeth was noted in a few cases.

Gums.—Pyorrhea was observed in forty-five persons, occasionally with readily bleeding gums. There were but two cases of gingivitis so marked as to suggest some disease other than pyorrhea. For the purposes of this study no attempt has been made to differentiate between gingivitis and the inflamed gums associated with pyorrhea.

In three men there was observed a definite "blue line" in the gums, somewhat similar to the Burtonian line of lead poisoning. The markings were dis-

tinctly punctate, blue-black in color, and finer than those commonly seen in cases of poisoning by lead. No conclusive evidence of lead absorption was obtained. One of the three men was a coner, the other two were sizers.

Mouth and Throat.—Twenty-two persons gave a reasonably trustworthy history of salivation, usually very moderate in degree; only three showed salivation when examined.

Twenty-five men were recorded as having a sensation of dryness of the throat; eighteen, a sensation of tickling. Eleven had sore tongues. Eighteen admitted having, upon occasion, noted a metallic taste, though reliable information regarding this matter was difficult to obtain.

Coated tongues were observed in twenty-six of the group, throats of dry appearance in six, and dusky mucosae in nineteen. Light patches on mucous membranes were observed in but two cases. No noteworthy odor of the breath was reported. Five men had slight speech defects.

Lymph Nodes.—Slight or moderate general adenopathy was recorded in thirty-six instances.

Cardio-Respiratory Symptoms.—Respiratory infections were reported as common. Forty-nine individuals gave a history of frequent colds, sixteen of pneumonia, eighteen of pleurisy, forty-nine of frequent coughs, and nine of hemoptysis. Statements regarding fever were untrustworthy.

Examination of the lungs disclosed various positive findings in thirty-two cases, for the most part signs of chronic bronchitis or of old pleuritis. Patches of dulness with increased fremitus and coarse râles were occasionally encountered. No case of active tuberculosis was recognized.

X-ray examination of a portion of the group not specially selected showed numerous cases of marked hilus infiltration, diminished radiance of one or both apices, numerous soft glands, and occasionally diffuse mottling. The following case reports are cited by way of illustration:

Case 7.—This man, aged 54, had been employed as a shaver for seventeen years. Physical examination of the chest was negative; X-ray examination showed coarse mottling scattered throughout both chests. Both apices were dull.

Case 15.—This man was 48 years old and had been employed as a finisher for fifteen years. Physical examination showed slightly impaired resonance; X-ray examination showed hilus infiltration, coarse peribronchial thickening, mottling throughout the entire right chest and upper lobe. The right apex was distinctly dull. The findings resembled tuberculosis.

Case 58.—This man, aged 62, had worked as a mixer in the blowing room for thirty-three years. Physical examination of the chest was negative; X-ray examination showed marked hilus infiltration, increased soft glands, and mottling scattered throughout both chests. The left upper lobe was distinctly dull. The findings resembled tuberculosis.

Case 60.—This man, aged 26, had been a starter for eight years. Physical examination of the chest disclosed dulness of the left upper lobe; X-ray examination showed marked hilus infiltration extending throughout both chests, and fine scattered mottling.

Broadly speaking, the radiographic findings, while in certain instances offering evidence of dust inhalation, were not notably distinguished from those ordinarily obtainable upon the examination of any group of men of like ages and numbers.

Twenty-two individuals gave a history of some degree of dyspnea; twenty-seven complained of palpitation; six appeared cyanotic; and fifteen were slightly or moderately edematous. Examination of the heart in ten cases revealed

evidence of disease, particularly hypertrophy and dilatation. Thirty-nine persons had a systolic blood pressure exceeding the age plus 110, the average excess over age plus 110 being 14.4 (mm. Hg). The average pulse pressure was 56.4 points. The age distribution of the members of this group was as follows:

Age Years	No.	Av. Excess over Age plus 110	Av. Pulse Pressure
20-29	7	14.0	46.4
30-39	18	10.7	52.5
40-49	6	23.5	68.5
50-59	5	8.6	60.0
60 and over	3	28.6	74.0
Total	39	14.4	56.4

Kidneys.—Of twenty-one specimens of urine obtained from these thirty-nine persons, five showed albumin. Fifty-eight men from the entire group of 100 reported nocturia. A definite history of hematuria was obtained in but one instance, associated with evidence of renal colic.

Gastro-Intestinal Findings.—No abnormal masses were found upon abdominal examination. Five persons were found to have inguinal herniae.

It is noteworthy that but one person complained of lack of appetite. Thirteen believed their digestion to be poor. Twenty-one were constipated. Ten reported occasional diarrhea. Hemorrhoids were noted in sixteen instances. Abdominal pain or distress was not strikingly manifest, and in the majority of the fifteen cases recorded the pain was in the epigastrium.

Posture.—The posture of approximately half of the men examined was exceedingly poor, the attitude being characterized by marked lumbar lordosis. Flattened chests and pendulous abdomens were frequently observed.

Neuromuscular Findings. — Thirteen men suffered from headache occasionally or frequently, sixteen others but rarely. No characteristic localization was apparent. Forty-three individuals stated that they were subject to attacks of dizziness, which in many instances was said to be marked.

Of twenty-six persons who complained of pain in the arms or legs, nine suffered from pain in the forearm, the hand, or the finger joints. In many cases the pain was presumably related to arthritis. Nineteen gave a history of tingling, numbness, or formication, usually of the fingers and hands. Of these, fourteen were sizers, two were blockers, one a wetter down, one a cutter, and one a blower. One dyer complained of itching legs.

Twenty-six of the men had had neuralgic pain, localized, for the most part, in the jaw or the cheek, and doubtless related in many instances to dental infection.

Tremors were observed in so many instances that particular care was exercised in the differentiation of degrees of tremor. The muscles of the face or orbits showed a slight or moderate tremor in seventeen cases. In thirty cases tremor of the tongue was recorded, in twenty-two of which it was slight. Tremor of the fingers, usually fine, was present in fifty-five cases, slight in twenty-eight, and moderate or marked in twenty-seven. Intention tremor of the fingers was observed in thirty-one persons, in twenty-two of whom it was moderate or marked, in nine slight. There were six additional doubtful cases.

Fibrillary twitchings of various muscles were reported in twenty-five cases, in seventeen of which they were moderate or marked. Evidence of this condition was, however, unsatisfactory in many instances.

Tremor of the muscles of the orbit alone was observed in three cases; of the tongue alone in three cases; of the fingers alone in twenty-four cases; of the muscles of the orbit and of the tongue in two cases; of the orbit and of the fingers in six cases; of the tongue and of the fingers in nineteen cases; of the orbit, tongue, and fingers in six cases.

The power of the flexor muscles of the forearms was estimated as fair in eleven cases, and as poor in but two cases; while the power of the extensor group was considered fair in thirteen cases, and poor in five.

Knee jerks were not obtained in four cases, and apparently were diminished in four others. One positive Romberg test was observed.

Insomnia was noted with considerable frequency. Thirty-three men had difficulty in sleeping. . Several complained only of restlessness, while many others could not sleep for a few hours after going to bed, or wakened early and could not fall asleep again.

Thirty-nine complained of excessive fatigue. In recording these cases an effort was made to exclude reports of ordinary weariness. Numerous circumstantial details indicated that certain persons were finishing the day's work with little or no reserve energy. A history of night blindness was obtained in four cases.

Thirty-four men admitted, on careful questioning, that they were frequently discouraged and "blue." It was, of course, difficult or impossible to distinguish the mental depression resulting from the relative inactivity of industry from that possibly of toxic origin. One man did not wish to see anyone when depressed, and another felt blue and "would like to be dead instead of alive."

Fifty-nine members of the group considered themselves as abnormally nervous and irritable. In many instances this irritability was attributed by the men to the presence of strangers, to the necessity for unusual work, or to anger. The character of the nervous reactions is perhaps best exemplified by the statements of some of the men themselves.

CASE 4.—"I 'fraid for boss, 'fraid boss gimme hell!"

CASE 16.—"Sometime mek me mad, I look lak a crazy."

CASE 17.—"If anybody ask me to do something quick, I shake."

CASE 30.—"Gets worse if I'm watched." He would slow up, if watched at work.

CASE 41.—This man became nervous, trembled, and stopped work as soon as a stranger came in. He also felt weak in his knees.

CASE 50.—"Feels sometimes as if I had done something wrong, as if somebody was after me." When he gets excited "then can't talk hardly at all." He becomes nervous if he is watched, and his legs "starta wiggle."

CASE 54.—"Gets all thumbs."

CASE 103.—"If I'm watched I seem to lose control of myself—don't do the work as I ought to do it—as well as I could do it. I get the idea that someone is looking at me when no one is. Feel as though I'm ready to fly."

Mercury Poisoning.—In discussing mercury poisoning among felt hatters many authors have emphasized the importance of salivation, dryness of the mouth, gingivitis, a blue line in the gums, tremors, and psychic irritability.[1] In the course of the clinical study, the results of which are here presented, these six symptoms or signs were recorded with the following frequency: salivation, 22; dryness of the mouth or throat, 25; gingivitis (with pyorrhea), 45; blue line, 3; tremors, 61; psychic irritability, 59.

[1] See Hamilton, A.: Industrial Diseases of Fur Cutters and Hatters. THIS JOUR., Sept., 1922, 4, No. 5, 219.

Of the 100 men examined, there were fifty-three who presented at least two of the above six signs or symptoms. There were other cases in which either a tremor, or marked salivation, or a blue line was noted, such suggestions of possible mercurialism, however, lacking supporting evidence. Of the fifty-three cases, ten have been eliminated as questionable for various reasons, such as uncertainty regarding the severity of psychic disturbance or tremors. The remaining forty-three cases showing quite definite signs of mercurialism were classified according to trade process, age, and experience as follows:

Process	No.	% of All Similarly Engaged	Av. Age Years	Av. Duration of Service Years
Fur Workers	*3*	*37.5*	*26.6*	*2.6*
Plucking	1	100.0	34.0	2.0
Carrotting	1	25.0	23.0	3.0
Cutting	1	100.0	23.0	3.0
Back Shop	*31*	*44.9*	*42.0*	*19.8*
Blowing	1	100.0	62.0	33.0
Coning	3	50.0	38.3	15.6
Hardening	1	50.0	43.0	25.0
Starting	1	33.3	26.0	8.0
Sizing	20	41.6	42.3	20.6
Blocking	3	75.0	46.3	26.6
Napping	1	100.0	33.0	16.0
Velouring	1	100.0	39.0	4.0
Finishing	*9*	*39.1*	*53.5*	*29.2*
Total	*43*	*43.0*	*43.3*	*21.2*

Among the group of forty-three cases with definite signs of mercurial poisoning, salivation was noted in seventeen, dryness of the throat in eight, pyorrhea or gingivitis in twenty-one, a blue line in two, tremor in forty, and psychic irritability in thirty-seven. Fourteen cases presented two of the symptoms, usually tremor and psychic disturbance; twenty cases presented three of the symptoms, usually tremor, psychic irritability, and gingivitis; eight presented four of the symptoms; and one case presented tremor, psychic irritability, salivation, gingivitis, and a blue line.

Eighteen of the forty-three men had abnormally high blood pressure. Urine analyses in thirteen of the eighteen cases revealed albumin in but four instances. Edema, usually of the ankles, was noted in ten cases of the group of forty-three, associated with high blood pressure in six persons, and with albuminuria and hypertension in two. In seven cases there was fairly frequent diarrhea.

Ten of the group of forty-three men had sore tongues, associated with salivation in three cases. Of twelve who had noted a metallic taste, seven also gave a history of salivation. In four additional cases the history of metallic taste was inconclusive.

In fourteen cases there was a suggestion of weakness of the muscles of the forearms, especially of the extensor group. In no case was there marked paresis. Thirteen men complained of numbness, tingling or itching, particularly of the fingers. Sixteen gave a history of twitching muscles, most often noted when in bed. Thirteen reported pain in the extremities, especially in the joints of the hands and arms, or in the knees.

Twenty men gave a history of discouragement, twenty-one of attacks of dizziness, and nineteen of insomnia. Psychic irritability, observed in thirty-seven cases among the group of forty-three, was associated with discouragement in twenty of these cases, with dizziness in twenty cases, and with insomnia in fifteen cases.

Of the forty-three men who, it may be assumed, presented evidence of mercurial poisoning, five should be considered as severely affected, fourteen moderately, and twenty-four slightly. There were, in addition, ten cases regarded as somewhat questionable, though there is

no clear demarcation between these cases and those of the group of workers slightly affected.

Case Reports

Case 12. *History.* — This employee, an Irishman, married, aged 48, had done blocking for twenty years, and during the year previous to this examination had done sizing. He gave a history of heavy drinking formerly, and of heavy use of tobacco at the time of examination. He stated that a Wassermann test made four years previously had been negative.

His vision was failing, but he wore no glasses. His hearing was normal, and he did not complain of tinnitus. He said that he had an occasional headache and frequent toothache, but had noticed no salivation nor metallic taste, nor dryness of the mouth, nor sore throat. He complained of no cardiorespiratory symptoms except slight dyspnea. He gave no history of edema. His appetite was good, and his digestion normal. He said that he had diarrhea occasionally but was never troubled with constipation. He had had nocturia only rarely.

Physical Examination.—He was a robust, stout man of ruddy complexion. His pupils were slightly irregular and reacted poorly to light. The muscles of the orbits showed a slight tremor, and there was twitching of the lips. His teeth were in poor condition and his gums showed marked gingivitis. There were small light plaques on the buccal mucosa. There was slight tremor of the tongue, but no coating. There was no adenopathy. Examination of the lungs, heart, and abdomen was negative. The pulse was 68.

Marked tremor of the fingers was noticed, together with intention tremor. The flexor and extensor muscles of the forearms were powerful. No changes in skin sense were noted. Knee jerks were present and Romberg test was negative. The palms of the hands were calloused and there was contraction of the right fourth finger, relative to which the man gave a history of injury in childhood.

The man said that he was readily irritable and felt blue. Previous to treatment for "kidney trouble," three months before the present examination, he had had attacks of dizziness. The urine showed a slight trace of albumin. Systolic blood pressure was 168; diastolic, 98.

X-ray examination disclosed a moderate degree of hilus infiltration, with somewhat increased density in the upper lobes of the lungs.

Case 41. *History.*—This man, a Czecho-Slovakian, married, aged 46, had done sizing for fifteen years. He said that he had drunk wine and used much tobacco. He had been troubled with watering eyes, and had worn glasses for five years. He gave a history of hemicrania for many years, but gave no history of vomiting. He did not report deafness but said that he had noticed tinnitus, accompanied by headache. For two months previous to this examination he had noticed a metallic taste "like rusty iron," and for two years had had salivation. He gave no history of dryness of the mouth or soreness of the tongue. He complained of moderately frequent colds, and of slight coughs with much sputum. He did not report hemoptysis, however. There was no history of dyspnea or palpitation, or of edema. He complained of poor appetite and eructations, and of diarrhea, and said that for two months he had had ten movements a day. For two years he had had a slight pain in the right hypochondrium, and during that time had lost 10 pounds in weight.

Physical Examination.—The man was pallid in appearance. There was nothing abnormal about the pupillary reactions or about the muscles of the orbit. His gums showed a blue line, and he said that they bled with brushing. The mucosae were normal. His tonsils were large and protruding. No tremor or coating of the tongue was noted. There was marked adenopathy.

Examination of the lungs disclosed evidences of an old process at the right apex, probably tuberculosis. No X-ray was obtained. Examination of the heart gave negative results. The pulse was 80. The vessel walls were found to be moderately thickened. There is some question whether the liver edge was palpable.

Tremor of the fingers, together with intention tremor, was observed. No muscle twitching was recorded. The flexor muscles of the forearms were powerful; the extensors were less strong. No sensory changes were noticed. Knee jerks were present, and the Romberg test was negative. Systolic blood pressure was 186; diastolic, 110.

The man complained of a pain in the fourth right metacarpal phalangeal joint. He had marked calluses on both palms, and slight Dupuytren's contractions of the fourth and fifth fingers of the right hand. He said that he was nervously irritable, had attacks of trembling, and was embarrassed by the presence of strangers in the shop. He admitted

a feeling of discouragement. He gave a history of attacks of dizziness, marked insomnia, and of being readily fatigued.

CASE 50. *History.*—This man was a German, married, aged 64, who had done sizing for forty years. He gave a history of typhoid fever forty-three years previous to this examination. He said that he had drunk beer, and had used tobacco moderately. He denied having had venereal disease.

His vision was fair; he had worn glasses for reading for ten years. He gave no history of deafness or of headaches, but complained of continued tinnitus. His teeth were all out; he said that they had been loose for four or five years. He had not noticed any metallic taste, salivation, dryness of the mouth, or soreness of the tongue or throat. His speech was defective because he was "so nervous." He had had no respiratory symptoms, and no dyspnea nor palpitation. He reported marked edema of the legs. His appetite was good. He said that his bowels moved daily, and that after drinking milk he had diarrhea. For two years he had had moderate nocturia.

Physical Examination.—This man was of senile appearance. He had marked tremor and experienced great difficulty in unbuttoning his clothing. The movements of his hands resembled those of a mandolin player. His complexion was ruddy. His pupils reacted slightly to light. There was a rhythmic twitching of the muscles of the orbits, and quivering of the upper lip. He had no teeth. He said that his gums had bled formerly. The buccal mucosae were slightly blueish, and there was salivation. No tremor of the tongue was recorded. Examination of the lungs showed a slight increase of physiological signs in the right apex. His heart was normal. His pulse was 56. A slight thickening of the vessel walls was noticed. Examination of the abdomen gave negative results.

There was marked coarse tremor of the hands and arms, and quivering of the legs, which was strikingly increased when an effort was made to control the muscles in careful movements. There was marked fibrillary twitching. The flexors of the forearms were weak; the extensors were of normal power. The man complained of cramping sensations in the limbs, and of pain in the back. With the Romberg test the tremor subsided. He said that when he was excited he was almost unable to speak. He acknowledged feeling greatly discouraged and blue. He said that he sometimes had attacks of dizziness, which cleared quickly but which had once or twice caused him to fall. He said that he slept well; that he was often so fatigued by work that he "can hardly walk home." There was a slight Dupuytren's contraction of the fourth finger of both hands.

It was difficult to obtain his blood pressure because of the marked tremor of the arm. Systolic pressure was 130; diastolic, 84.

X-ray examination disclosed a slight increase of the hilus shadows within normal limits.

CASE 58. *History.*—This workman, an American of Irish parentage, a widower, aged 62, had been employed as a mixer in the blowing room for thirty-three years. He gave a history of scarlet fever in childhood, with subsequent partial deafness. He denied having had venereal disease.

He had worn glasses for twenty-five years. For one year previous to this examination he had had marked occipital headache and tinnitus. He complained of frequent toothache, and of soreness of the tongue, but gave no history of metallic taste, dryness of the throat, or sore throat. He said that he had noticed salivation, and that his pillow became stained from it. He stated that he had occasional colds and cough with sputum. He had noticed palpitation but no dyspnea nor cyanosis. He complained of edema of the feet in the morning. His appetite was good and he was not troubled with indigestion. His bowels moved with laxatives. He said that he had nocturia two or three times, and that occasionally he had hematuria.

Physical Examination.—This workman's skin was clear and pale, and he appeared to be fairly well nourished. He had one molar and many roots left. He had marked pyorrhea; his gums showed a dark line, but the markings were not punctate. The mucosa was cyanosed. There was a slight tremor of the tongue and a moderate coating. No adenopathy was recorded. Examination of the lungs gave negative findings. The heart was found to be enlarged toward the left side, and aortic second sound accentuated. The pulse was 124. Examination of the abdomen was negative.

There was marked tremor of the extremities, especially of the legs. Vertical oscillations were noted when he seated himself. He unbuttoned his clothing with ease, but found it difficult to touch the end of a pencil with his finger. About seven months previous to this examination he had left work because of the "shakes," and had been on crutches for three months. Fibrillary twitching was present. The power of the flexors of the forearms was fair; the power of the extensors, poor. The knee jerks were present; Romberg test was positive. He said that he had

noticed formication. Of late he had been somewhat discouraged and depressed. Following a quick movement he would become dizzy, and would almost fall. He said that he slept well.

Systolic blood pressure was 220; diastolic, 150. The urine showed a slight trace of albumin.

X-ray examination showed marked hilus infiltration, increased soft glands, and mottling scattered throughout both chests. The left upper lobe of the lung was distinctly dull. The findings resembled tuberculosis.

Summary

1. This article gives a presentation of the findings of the examinations of one hundred hatters' fur workers, hat makers, and finishers of varying ages, nationalities and occupations, most of whom considered themselves in reasonably good health.

2. A number of cases of heavy calluses of the hands and of Dupuytren's contraction were observed.

3. No cases of active tuberculosis were recognized. Radiographs of 56 per cent. of the group disclosed no notable incidence of serious pulmonary disease.

4. In 39 per cent. of the cases the systolic blood pressure was found to be abnormally high.

5. Certain accepted evidences of mercurialism, especially tremor and psychic irritability, were frequently encountered. Forty-three per cent. of the group were considered to be in some degree poisoned by mercury.

Grateful acknowledgment is made to Dr. Robert W. Hinds and Mr. Daniel N. Barber for assistance in the conduct of the examinations; to Dr. Herman Osgood, who served as roentgenologist; to the officers of the organized hatters of Danbury; and to the staff of the Industrial Clinic of the Massachusetts General Hospital for its aid in connection with the analysis of the material collected.

A NOTE ON THE SILICA CONTENT OF SOME FACTORY DUSTS *

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THE incidence of phthisis among boot and shoe makers is commonly known to be high, and various reasons have been put forward in explanation. Gold miners, masons, and other workers in silicious materials, however, have a much higher phthisis mortality, which has been shown to be due to the inhalation of silica dust (1). The inhalation of this dust is followed by a fibrous condition of the lungs, known as silicosis: this fibrosed lung in time becomes infected with the tubercle bacillus. Silicosis, however, can only be brought about by the inhalation of free silica, SiO_2; combined silica is without effect—clay which contains 50 per cent. or more silica is quite innocuous, the silica being combined with alumina. Obviously, then, it is free silica which must be looked for in industrial dusts; an analysis which simply gives the total silica content is useless. As silica is by no means an uncommon substance, industrial physicians may naturally harbor the idea that an excessive amount of silica may be present in the dust of boot and shoe factories, and may be the cause of the high phthisis rate in that industry.

Silicosis has also been advanced as a cause of printers' phthisis. Roos (2) investigated the dust from printers' workrooms and found small amounts of silica present, but less than in the dust of living rooms. He therefore concluded that silica was not responsible for printers' phthisis.

Through the kindness of Dr. R. Pratt of Leicester, an opportunity arose to investigate the dust from a large boot and shoe factory, and also from a hosiery factory, in that town. The hosiery industry, it should be noted, has not a high phthisis rate.

Examination of Dust from Boot and Shoe, and Hosiery Factories

Of the samples of dust sent to the laboratory from the factories, most stress was laid on those which came from the roof beams and the blades of the exhaust ventilating fans. Microscopic examination of these samples showed, in every case, the presence of a few sharp-edged particles which were believed to be sand. The analyses, except that of the free silica, were carried out by standard methods. There is no very satisfactory chemical method of determining free silica in a mixture containing much combined silica, and a mechanical method of separation was therefore used, the dust being separated into various fractions by shaking with water and by partial sedimentation. By determining the total amount of silica in the various fractions, it was possible to calculate approximately the amount of free silica. A fraction containing 90 per cent. total silica, for example, necessarily consisted almost entirely of free silica. The other inorganic bodies present were largely iron and alumina.

Table 1 shows the results obtained from the analysis of the dust of the two factories investigated. It will be seen from this table that the dust from the "phthisis" boot and shoe factory con-

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tained no more free silica than that from the "non-phthisis" hosiery factory. Probably the silica found was, for the most part, brought into the factory on the workers' boots.

By way of comparison with these results, some samples of dust from our laboratory shelves, etc., were analyzed and were found to contain 16 per cent. total silica and 7 per cent. free silica. Sir James Crichton-Browne found 21 per cent. silica in dust taken from the top of a wardrobe in a London house. There is, in fact, some silica in all dusts. This is not surprising, however, considering the wide distribution of the substance.

From the results of this investigation, it must be concluded that silica plays no part in boot and shoe makers' phthisis.

TABLE 1.—RESULTS OBTAINED FROM ANALYSIS OF DUST SAMPLES FROM BOOT AND SHOE, AND HOSIERY FACTORIES

Factory	Source of Dust	Composition of Dust: Organic Matter %	Total Silica %	Free Silica %	Phthisis Death Rate[1]
Boot and Shoe[2]	finishing room: exhaust fan blades	62	10.4	3.0	235
Boot and Shoe	finishing room: beams	58	18.6	4.2	235
Boot and Shoe	floor sweepings: average of various rooms	51	18.4	5.1	235
Hosiery	winding room: beams	51	20.5	8.0	176
Hosiery	main producing room: exhaust fan blades	71	8.2	4.0	176
Hosiery	main producing room: beams	60	16.5	6.1	176

[1]Standardized mortality rates.
[2]A sample of leather dust from the finishing room showed only 0.17 per cent. total silica.

SUMMARY

1. Pulmonary silicosis, the fore-runner of tuberculous-silicosis, follows only upon the inhalation of the dust of free silica.

2. Silica is not responsible for printers' phthisis.

3. The amount of free silica found in dust from a boot and shoe factory does not exceed that in dust from a hosiery factory, from a laboratory, or from a London house.

4. Evidence does not place the responsibility for boot and shoe makers' phthisis upon silica.

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A STUDY OF THE MORTALITY OF COAL MINERS, ENGLAND AND WALES

(Continued)

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Resume of Points for Consideration

1. There is a great diversity in the death rates on the various coal fields not fully accounted for by local non-industrial influences.

2. This diversity is mainly accounted for by the fact that the fields with higher death rates experience higher mortality rates from phthisis, pneumonia, bronchitis, and accidents.

3. The mortality from phthisis, while varying considerably on the different fields, is low on all fields.

4. Men at the coal face as life progresses suffer more from phthisis than others employed in the mining industry; the only exceptions are found in Monmouthshire and South Wales and in Nottingham where this occupational group suffers less than the other two groups.

5. Pneumonia is in excess on certain coal fields, notably in Lancashire.

6. The tendency is for pneumonia, when in excess, to affect men at the face, but an exception is found in Monmouthshire and South Wales and in Nottingham where this group suffers less from the disease than the other two groups.

7. There is a tendency for a high death rate from pneumonia among both groups of men employed under ground to be closely associated with a comparatively high death rate from phthisis.

8. Bronchitis also is found with a wide range of mortality rates which frequently exceed the standard, the excess being most pronounced where the mortality rates from phthisis and pneumonia are high.

9. Generally speaking, the tendency is for bronchitis, when in excess, to affect men at the face particularly late in life.

10. The accident rates are high on all coal fields, and the fields with high mortality rates from other causes experience high accident rates.

11. The outstanding feature of the accident mortality is the way in which it groups the fields in an order similar to that established by mortality from the respiratory diseases.

12. Others below ground succumb from accidents more than either of the other groups. Men at the coal face come second. On two fields where the accident rate is low—Nottingham, and Durham and Northumberland—the position is reversed.

13. Men at the face in Monmouthshire and South Wales in relation to the other two occupational groups of that field present an exception in that the mortality rates from phthisis, pneumonia, and accidents are all comparatively lower than on other fields.

Discussion

The outstanding features of the points enumerated are (*a*) the way in which the four causes of death considered are

either all high or all low on any given coal field; (*b*) the way in which the relative position of the three occupational groups with respect to the four causes of death is maintained on the different fields; and (*c*) the fact that when an exception occurs, as in Monmouthshire and South Wales and in Nottingham, the tendency is for all four causes of death to be affected. The deductions follow that there must be some common factor or factors (1) which influence these four causes of death; (2) which vary in intensity on the different fields; (3) which exert a cumulative effect increasing in power with length of occupation; (4) which affect men at the face more than others; but (5) which in Monmouthshire and South Wales affect men at the face less than others.

Phthisis and Respiratory Diseases

Special consideration may first be given to the mortality from phthisis because something is known of the influences which determine it.

Phthisis, or pulmonary tuberculosis, is an infectious disease transmitted from person to person. Its prevalence is influenced by (*a*) aggregation of individuals, which increases opportunities for passing on infection; (*b*) general personal health or power of resisting infection; and (*c*) exposure to the inhalation of silica dust, which has a peculiar capacity for sensitizing the tissues to tuberculous infection.

(*a*) Coal mining does not bring workers together as do industries like tailoring, bootmaking, and printing, in which phthisis is unduly prevalent; nor is there any marked difference between the aggregation of workers on the different coal fields, or in the different occupational groups considered. This influence, if it plays any part in this industry, may be a contributory influence determining why the industry as a whole experiences a low mortality from the disease.

(*b*) An important industrial influence affecting health is ventilation, and if the South Wales field were unique in employing the longwall method of coal getting in which the man at the face gets better ventilation than in the pillar and stall method, this influence might account for the phenomena noted; but in fact this is not so. There is no reason for supposing that the general personal health of workers on the various fields or among the various occupational groups on the same field differs in a way which would account for the facts.

TABLE 16.—MEDIAN AGE AT DEATH FROM PHTHISIS AMONG COAL MINERS, AGED 15 YEARS AND OVER, DISTRIBUTED ACCORDING TO OCCUPATION [1]

Coal Field	Workers at Face	Others below Ground	Workers above Ground
Nottinghamshire	30	28	24
Derbyshire	35	19	30
Northumberland and Durham	34-35	26-27	24
Monmouthshire and South Wales	37	37-38	40-41
Staffordshire	36	22-23	34
Yorkshire	41	21	27
Lancashire	42	32	29
England and Wales..	37-38	30-31	31

[1] The data of this table have not been standardized for age distribution of the occupational groups.

(*c*) The question of the inhalation of silica dust calls for careful consideration. The coal measures, particularly the strata intervening between the coal seams, are known to contain definite amounts of silica, the dust of which, when inhaled, has been shown to set up in the lungs a form of fibrosis known as silicosis. Persons with silicosis are particularly liable to succumb to pulmonary tuberculosis, and then their deaths are ascribed simply to phthisis.

TABLE 17.—MEAN ANNUAL DEATH RATE OF COAL MINERS FROM BRIGHT'S DISEASE[1]

District	Age Group								15 Years and Over	
	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75 and Over	Crude Death Rate	Standardized Death Rate
(a) Workers at the Face										
Northumberland and Durham	0.152	0.150	0.085	0.209	0.435	1.795	2.755	2.137	0.403	0.37
Lancashire	0.139	0.049	0.098	0.315	0.398	1.753	3.152	2.874	0.442	0.38
Yorkshire	0.223	0.060	0.103	0.248	0.289	1.229	2.876	1.787	0.322	0.32
Derbyshire	0.141	— —	0.058	0.281	0.695	1.053	4.826	— —	0.379	0.37
Nottinghamshire ...	— —	— —	0.126	0.173	0.100	1.382	1.605	— —	0.223	0.21
Staffordshire	— —	0.133	0.063	0.163	0.323	0.474	0.812	3.195	0.219	0.18
Monmouthshire and South Wales	0.012	— —	0.045	0.125	0.337	1.254	1.816	0.736	0.157	0.21
Other districts......	0.093	0.042	0.112	0.214	0.261	0.884	3.911	4.357	0.354	0.31
England and Wales (all districts)....	0.053	0.051	0.081	0.210	0.362	1.306	2.731	2.161	0.301	0.29
(b) Other Workers below Ground										
Northumberland and Durham	0.011	0.075	0.082	0.063	0.196	0.475	1.939	8.081	0.158	0.19
Lancashire	— —	0.049	— —	0.132	— —	0.761	— —	5.747	0.078	0.11
Yorkshire	0.041	0.048	— —	0.218	0.122	0.934	0.693	— —	0.101	0.15
Derbyshire	— —	— —	— —	— —	0.757	0.631	8.714	— —	0.186	0.36
Nottinghamshire ...	— —	— —	— —	0.392	0.571	0.901	3.175	— —	0.170	0.29
Staffordshire	— —	0.127	— —	— —	0.263	0.462	— —	10.416	0.088	0.13
Monmouthshire and South Wales	— —	0.120	0.037	0.174	0.390	0.795	2.349	6.116	0.235	0.25
Other districts.... ..	0.057	— —	— —	— —	0.203	— —	1.768	5.555	0.099	0.11
England and Wales (all districts)....	0.016	0.070	0.032	0.125	0.250	0.607	1.835	5.964	0.150	0.19
(c) Workers above Ground										
Northumberland and Durham	0.063	— —	0.083	— —	0.288	0.941	0.418	12.821	0.231	0.20
Lancashire	— —	— —	— —	— —	0.225	1.479	0.733	7.407	0.264	0.18
Yorkshire	— —	— —	0.169	0.136	0.547	1.120	1.961	6.289	0.316	0.28
Derbyshire	— —	— —	— —	— —	— —	0.487	2.8[illegible]5	— —	0.197	0.11
Nottinghamshire ...	— —	— —	— —	— —	— —	0.087	1.488	— —	0.147	0.08
Staffordshire	0.231	— —	— —	— —	0.355	— —	3.003	— —	0.247	0.16
Monmouthshire and South Wales	— —	— —	— —	0.305	0.278	1.580	3.106	— —	0.397	0.28
Other districts......	— —	— —	— —	— —	— —	0.038	4.762	— —	0.081	0.13
England and Wales (all districts)....	0.039	— —	0.037	0.090	0.258	0.958	1.700	4.016	0.258	0.19

[1]For the purpose of standardization, the age distribution of the coal miners in each district and occupation has been assumed to be identical with that of all coal miners in all occupations in England and Wales.

The suggestion that tuberculous silicosis may account for the diversities in the prevalence of phthisis found among coal miners—even though it may be considerably less common among coal miners than among tin miners, stone masons, and others—necessitates reference to this disease. The Royal Commission on Metalliferous Mines and Quarries, when discussing this disease, summarizes the question in these words:

> If in any class a high death rate from pulmonary tuberculosis is found occurring at a later period of life than is usual for pulmonary tuberculosis, and if this high death rate is associated with a high death rate from other respiratory diseases, then this class is exposed to the inhalation of injurious dust.

The first criterion, then, is that the disease must occur at a later period of life than is usual. A simple effort to test this point is shown in Table 16. Although the data given in this table cannot be taken as more than suggestive, owing to the complication of unequal age distribution in the occupational groups on the different fields, the tendency displayed is for men at the face (who have been found to suffer most from phthisis), when dying of phthisis, to be distinctly older than members of either of the other occupational groups; for this difference to be most pronounced on the fields where phthisis is most prevalent; and for this difference not to be found in Monmouthshire and South Wales. So far, then, as the data may be relied upon, the records stand the first test.

The second criterion associates the death rate from pulmonary tuberculosis with a high death rate from other respiratory diseases. The examination of mortality data already made has shown that the prevalence of phthisis varies on the different fields with the prevalence of the other respiratory diseases, pneumonia and bronchitis; and, further, that the same thing holds good for the occupational groups concerned. The second test also is thus complied with.

While the suggestion put forward may explain the unequal distribution of phthisis on the coal fields, it does not necessarily cover the whole case in regard to "other respiratory diseases," including pneumonia and bronchitis. These diseases may result from other causes than exposure to silica dust, as, for instance, from exposure to other insoluble dusts arising from basalts and the like, or to sudden changes of temperature due to keen drafts in the main ingoing air ways, or on the surface. Prevalence of "other respiratory diseases," not associated in any way with the prevalence of phthisis, may be due to such causes; but from the series of mortality data now under consideration no definite conclusions as to the influence of such exposures can be drawn.

If investigation should prove that coal on the South Wales field either contains but little silica, or is got by the man at the face with a minimum disturbance of the intervening strata; and that in the Derbyshire and Nottinghamshire fields the amount of silica present in the coal measures is less than on the other fields, we should be justified in holding exposure to dust inhalation to be an important influence underlying the diverse mortality rates from phthisis, pneumonia, and bronchitis, found to exist on the different fields.

Bright's Disease

There still remains a further statistical test: Occupational groups exposed to the inhalation of silica dust have been noted to experience, in addition to an excessive mortality from phthisis and other respiratory diseases, a high mortality from Bright's disease, which may

be attributed to the same cause. The number of deaths occurring from this disease among coal miners, when distributed by coal field and occupation, is too small to furnish reliable death rates; hence small differences in the standardized death rates must not be depended upon. Further, the death rate from phthisis among coal miners, which is uniformly low, suggests that if silica dust exerts any influence, this influence is not a powerful one—in other words, the amount of silica inhaled must be small; or, that there is present some counteracting influence minimizing the tendency of silica dust to pave the way for tuberculous infection, which influence may or may not counteract the tendency of silica to affect the kidneys.

Nevertheless, the deduction may be drawn from the data of Table 17 that some relation exists between the death rates from phthisis and from Bright's disease. Thus, workers at the face on all coal fields, who experience more phthisis than the other two occupational groups, are also found suffering a higher mortality from Bright's disease. When the separate coal fields are considered, however, the death rates from Bright's disease among men at the face are found to fall into two groups: one group, which includes Lancashire, Durham and Northumberland, Derbyshire and Yorkshire, stands above and distinct from the other group, which includes Nottinghamshire, South Wales, and Staffordshire. The first group of four includes three fields —*i.e.*, Yorkshire, Lancashire and Durham, and Northumberland, which, for

TABLE 18.—AVERAGE DEPTHS OF WORKINGS IN COAL FIELDS OF UNITED KINGDOM (BASED ON DEPTHS OF SHAFTS)

Division	Coal Field	Average Working Depth *Feet*
Northern Division	Cumberland	900
	Durham	800
	Northumberland	400
York and N. Midland Division	Derbyshire	922
	Nottinghamshire	1,223
	Yorkshire	1,220
Lancashire, N. Wales and Ireland Division	Cheshire	420
	Lancashire	1,500
	Denbigh	1,020
	Flint	450
	Ireland	135
South Wales Division	South Wales and Monmouth	1,050
Midland and Southern Division	Bristol	1,290
	Derbyshire (South)	690
	Forest of Dean	750
	Kent	1,050
	Leicester	660
	Shropshire	750
	Somerset	1,080
	Staffordshire North	1,560
	Staffordshire South	420[1]
	Staffordshire Cannock Chase	900
	Warwick	1,500

[1] This average is apart from three of the largest pits—namely, Hamstead 2,100 feet deep; Sandwell Park 2,340 feet deep; and Baggeridge 1,950 feet deep.

this group of workers, stood highest in phthisis mortality; while the lower group of three includes two fields, Nottinghamshire and South Wales, which stood lowest.

For others below ground the only notable point is that for Nottinghamshire and South Wales, where the phthisis mortality of this occupational group was found to be unusual in being higher than that among men at the face, the mortality from Bright's disease follows the same course.

Probably this is as far as the available data permit this test to be applied, and all that can be said is that the test is not unfavorable to the suggestion that exposure to dust of silica may exert an influence on the mortality from respiratory diseases among coal miners.

Accidents

The causation of accidents in mines, since it is known, may be expected to throw some light on the whole matter. Two kinds of accidents, explosions and falls of ground, are peculiar to the mining industry. Explosions which lead to great disasters are fortunately sufficiently exceptional to permit them to be disregarded for the moment, although the presence in the workings of gases which give rise to these explosions cannot be quite disregarded in view of the somewhat remote possibility of these gases affecting the worker's health when inhaled over long periods of time. The other most distinctive cause of mining accidents is falls of ground—a cause which, in 1911, a year in which there was no great disaster, was responsible for 50.4 per cent. of all accidents on English and Welsh coal fields. Falls of ground mainly concern men at the face, and other forms of accidents concern the other workers; but since there are more men employed at the face than elsewhere (510,282 in all districts, compared with 350,549 for others below ground and workers above ground taken together[3]), the accident rate so caused is comparatively low for this occupational group. Dust rising from falls of ground can hardly be looked upon as being generated sufficiently frequently to be the origin of that dust, the inhalation of which is suggested to account for the prevalence of respiratory diseases; but if coal in measures underlying sandy shales contains more silica than coal underlying a good sandstone roof, then some explanation of the relation found to exist between the different mortality data would be forthcoming. Falls of ground depend upon two main causes: (1) the nature of the strata overlying the coal measure being worked; and (2) the amount of cover—*i.e.*, the depth of the workings.

1. Information as to the strata overlying coal measures, particularly in relation to chemical composition, is needed.[4]

2. The average depths of the mines on the different fields have been recently obtained by the Mines Department, and are given in Table 18.

General Theory

On the theory now proposed, death rates from respiratory diseases would be related to the silica content of the coal worked, and also of the roof. Falls of ground are related to the composition of the roof and to the depth of the workings. On this theory, in South Wales and Nottingham, there should be little

3. See also page 261 relative to number of men employed above ground.

4. I understand that in South Wales on parts of the field the roof is formed of sandstone, the Pennant seam, which provides a fairly stable roof; but on other coal fields sandy shales more frequently form the roof.

silica in the coal, and a good sandstone roof: this roof should be ripped by a group of men (included among others below ground), who, being thus exposed to injurious dust, suffer more from phthisis, pneumonia, and bronchitis. In Yorkshire the coal should contain some silica, but the roof should be of shales. In Lancashire coal should contain rather less silica than the coal in Yorkshire, but the roof should be of a rather insecure sandstone. In Derbyshire there should not be much silica in the coal or in the roof (unless there is very little roadripping). The mortality for Durham and Northumberland is stated together, but the Durham field appears, from the depth of the workings, to differ from the Northumberland field; similarly, the various parts of Staffordshire (mortality for which is given as a whole) differ considerably in the workings; no suggestions are, therefore, hazarded as to the geology of these fields.

BOOK REVIEW

Pulling Together. By *John T. Broderick*. Cloth. Pp. 141 and introduction and table of contents. Schenectady, N. Y.: Robson & Adee, 1922.

To say that the 141 pages of "Pulling Together" cover the field of industrial relations, could not, of course, be true. There is a marked tendency to stress the problem of employee representation, and other questions which are introduced group themselves, for the most part, around this central idea. The discussion is, as might be expected, quite sketchy. The writer displays a naïve zest for his subject which would make the book appeal primarily to the layman.

The text of the book is developed in the form of a conversation which is represented as taking place between the writer, a salesman and the president of a well-known corporation. The reader is unfortunately impressed at the outset with a lack of reality in the setting, which weakens the writer's natural tendency to express things well. The issues involved are serious ones. If the president of any influential corporation was actually a party to the conversation of the text, this fact should not be left in doubt; if the situation was fictitious, it seems as if, just at this time, the writer is taking an unfortunate liberty which makes the reader resentful, even against his will.

Aside from this regrettable defect in structural conception many things are said well. There is apparently no attempt to add to current thought on the questions involved. Those who know little of the current problems of industrial relations will do well to consider the writer's arguments. That industrial organization is at present viewing its problems of industrial relations from exactly the same angle as that of the writer is not to be determined here. It is true, however, that among our most progressive industries there has been a marked tendency in the last few years to adopt as a working hypothesis the fundamentals which he advocates.—*C. H. Paull.*

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RECENT INVESTIGATION ON ATMOSPHERIC CONDITIONS IN INDUSTRY*

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DURING the last three years a number of investigations on the atmospheric conditions under which certain industries are carried on have been made at the instance of the Industrial Fatigue Research Board. Their value lies largely in the fact that in all of them great use was made of the kata-thermometer, an instrument invented by Dr. L. E. Hill. This instrument has been described in detail by Orenstein and Ireland in a recent number of THIS JOURNAL (1). For the present purpose it is sufficient to say that it measures the *cooling power* of the air. This cooling power, as measured by the dry kata-thermometer, is dependent on two factors, the dry bulb temperature of the air, and its velocity of movement. By means of a simple formula it is possible to calculate the air velocity in a workshop from the cooling power. The cooling power of the wet kata-thermometer is more complicated, as it depends on the evaporation of moisture from the surface of the kata-thermometer bulb, as well as on temperature and air movement; but it has been shown by Hill, Vernon, and Hargood-Ash (2) that the wet kata cooling power can be calculated approximately from the wet bulb temperature and the air velocity in accordance with these formulae:

For air velocities below 1 meter per second

$$H' = (0.35 + 0.85\sqrt{v})\,\theta'$$

For air velocities above 1 meter per second

$$H' = (0.10 + 1.10\sqrt{v})\,\theta'$$

where v is the air velocity in meters per second, and θ' is the difference between 36.5°C. and the wet bulb temperature.

These formulae, and the corresponding dry kata formulae which are recorded by Orenstein and Ireland, were determined by two independent methods. In one of them the air movement was effected by drawing air through a "wind tunnel" by means of a propeller. In the other, the kata-thermometer was clamped to a metal rod which was

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revolved in a horizontal plane at a known rate, a correction being applied for the "swirl" set up. The two methods gave quite consistent results.

The adequate investigation of the atmospheric conditions in a workshop is inevitably a laborious process, as it is necessary to make observations, not only at various times during the course of the working day (and working night as well if there is a night shift), but at various times in the course of the year, in order to determine the experience of the workers at the extremes of heat and cold to which they are subjected in the course of their daily round of work. In addition to the observations in the shops themselves, it is very desirable to make extended observations in the air outside the shop, for the importance to be attached to a given kata-thermometer value depends greatly on the outside air conditions at the moment.

The observations to be described may conveniently be divided into two groups, according as they relate (1) to workshops where the nature of the industrial processes carried on does not, or should not, interfere with the atmospheric conditions to such an extent as to prevent the attainment of what is regarded as a normal standard; and (2) to shops where the industrial processes are such that the usual standards have to be relaxed to some extent.

Workshops with Normal Atmospheric Conditions

At the present stage of our investigations, the word "normal" is necessarily somewhat indefinite, for there is no general agreement as to what constitutes normality. Dr. L. E. Hill considers that the dry kata cooling power ought to be 6 or more, and the wet kata power, 18 or more. These are convenient standards which may be accepted for most purposes; but with high outdoor temperatures some relaxation may be necessary. Such relaxation is most easily determined by considering the temperature and the degree of air movement independently.

Firstly, therefore, we have to decide what constitutes a normal standard of temperature in a well-constructed workshop. An American firm suggested a temperature of 65° to 67° F. in shops where men are moderately active and able to move about, and a temperature of 55° to 65° in foundries, smithshops and carpenters' shops, where active work is the rule. At an English factory the standards suggested were several degrees lower, while Hambly and Bedford (3), as the result of their observations in the boot and shoe trade, suggested a temperature of 60° to 65° for an active operation such as sole-cutting. Vernon and Bedford (4) suggested a similar temperature for potters' shops, where the work is of a continuously active character, though it is not heavy. Such a temperature cannot be maintained in hot weather, but in England outdoor temperatures above 65° are seldom observed, except in the late morning and the afternoon, and as there is always a considerable delay in the transmission of heat from the air outside to the air inside a substantially built factory, it should be possible, as a rule, to keep the factory temperature only slightly above 65° when the outdoor temperature is 65°. At higher outdoor temperatures it is often possible to keep the factory temperature slightly *below* that outside, because of the delay in the transmission of heat. Standards of factory temperature in relation to outdoor temperature are suggested in Table 1.

The reasonableness of these standards is supported by data adduced by Vernon and Bedford, which relate to observations made in a fuse factory. One shop investigated was about 200 feet square, and it was confined to lathe work. The temperature near the center of the shop was taken at three-hour intervals between 9 A. M. and 6 P. M., for several months, and it was found that the

TABLE 1.—SUGGESTED STANDARDS OF TEMPERATURE AND COOLING POWER

Outdoor Temperature	Indoor Temperature	Dry Kata Cooling Power and Corresponding Air Velocity
° F.	° F.	
60 (or less)	62.5 (60 to 65)	6.0= 14 ft.; 7.0=31 ft.
65	67.0	6.0= 28 ft.; 6.5=40 ft.
70	71.0	6.0= 42 ft.
75	75.0	6.0= 94 ft.; 5.0=47 ft.
80	79.0	6.0=175 ft.; 5.0=97 ft. 4.0=42 ft.

average temperature varied only from 61.5° to 65.0° when the outdoor temperature varied from 37° to 57°. At higher outdoor temperatures the shop temperature usually showed a slight excess, and at 62°, 67° and 71°, it was respectively 4.1°, 1.9° and 1.2° greater in the shop; but at 77° it was 1.4° *lower* in the shop than outside. If the cooling power is kept at 6.0 at all temperatures, it follows that the air velocity must range from 14 feet per minute at a factory temperature of 62.5° to 175 feet at a factory temperature of 79°. This latter air velocity would be very difficult to maintain, and it has very seldom been found in the observations hitherto made. Even velocities of 94 to 97 feet, which correspond to a kata value of 5.0 at 79° and to one of 6.0 at 75°, are seldom attained; but the velocity of 47 feet, which is required to give a cooling power of 5.0 at a temperature of 75°, is frequently observed. I suggest, therefore, that Dr. Hill's standard of 6 should apply only to outdoor temperatures of 70° or less, and that at higher temperatures a standard of 5 should suffice, or even less than this at temperatures above 80°. The data obtained in the workshops of various industries will now be discussed in the light of the suggested standards.

The Boot and Shoe Industry.—This industry was subjected to an extensive examination by Hambly and Bedford (3), who investigated thirty-five factories, situated in seven different counties. They made observations at all times of the year; but for convenience of analysis they divided their results into "winter" and "summer" observations, according as they were made when the outdoor temperature was below or above 50° F. Altogether they made 377 winter observations and 276 summer observations; the frequency of occurrence of the various dry kata cooling powers is recorded (as percentages) in Table 2. Of the winter observations, all but 5 per cent. showed a kata cooling power of 6 or more, and they may therefore be regarded as satisfactory. Of the summer observations, 37 per cent. had a lower cooling power than 6, and 18 per cent. had a cooling power less than 5. To what extent were these low values dependent on high outdoor temperatures? A temperature of 70° or more was observed in only 10 per cent. of the summer observations, and a temperature of 80° was never observed; hence the frequency of occurrence of kata values below 6 was three or four times greater than that permitted by the standards suggested in Table 1. This excess of low values was due partly to the unduly high shop temperatures, and partly to insufficient air movement, as is indicated by the air velocities recorded in Table 3. It will be

seen that 18 per cent. of these observations show less velocity than 25 feet per minute, and 60 per cent. of them less than 41 feet. It is true that 20 per cent. of them showed a velocity of 52 feet and upwards, or sufficient to yield a kata cooling power of 5 at a temperature of 75°, but the high air velocities did not by any means always occur when the shop temperature was high, and accordingly the cooling power observed sometimes fell below 5, and even below 4.

In spite of this criticism, the atmospheric conditions observed in the boot and shoe industry must be regarded as fairly satisfactory, on the whole. The standard of cooling power attained applied almost equally well to all departments of the industry, as the median (or middle) cooling power in each of the six departments investigated was always 7.0 or more in winter, and 6.2 or more in summer. Hambly and Bedford point out, however, that this uniformity in the atmospheric conditions is contrary to the rule that cooling power ought to vary with the character of the work done. For instance, girls engaged in the fairly light sedentary work of boxing and treeing shoes were subject to lower temperatures and higher cooling rates than the men engaged in rather heavy manual work.

The Printing Trade.—In the printing works investigated, the atmospheric conditions were not nearly so satisfactory as in the boot and shoe factories. At the request of Dr. Hill, Mr. P. G. Edge made observations in ten printing works, all situated in London, but the majority of the data were collected in three large works. It will be seen from Table 2 that 216 observations were made in winter (January to April), and 66 in summer (June to July). A cooling power of less than 6 was observed in 38 per cent. of the winter observations, and in no less than 91 per cent. of the summer observations. This was due largely to the low air velocities, for it will be seen in Table 3 that the median velocity was only 20 feet per minute in winter, and 18 feet in summer, or not much more than half as great as in the boot and shoe factories.

The Pottery Industry.—Observations in the pottery industry were made by Vernon and Bedford (4). They were confined to potters' shops, where the workers are engaged in making plates, cups, saucers and other articles out of moist clay, or china "slip." The articles made are transferred immediately to the potters' drying stoves, usually situated in the middle of the shops, into which they almost invariably pour out large volumes of hot air. For this reason the shops are nearly always overheated, as was proved by making systematic series of observations in winter and in summer. The temperature in the majority of the shops was found to be from 5° to 9° above what is regarded as reasonable, and in some of them the temperature was over 70° F. for the larger part of the year. It might be thought that the passage of heat from the drying stoves to the shop is unavoidable, and that the kata records obtained ought to be discussed in the next section, under the heading of industries with abnormal atmospheric conditions. This is not so, for it has been shown (4) that the outward passage of heat is due to the faulty construction of most of the stoves, but that stoves do exist which retain practically all their heat. They are highly efficient in other ways, and ought certainly to be installed in place of the inefficient stoves now found in most pottery works.

Owing partly to the high shop tem-

peratures, the kata cooling power observed in potters' shops are usually very low. As can be seen from Table 2, 61 per cent. of the winter observations and 89 per cent. of the summer observations fell below 6. The median (or middle) cooling powers came to 5.6 and 4.5, respectively, as compared with values of 7.4 and 6.4 for winter and summer observations in boot and shoe factories. The low cooling power in potters' shops, however, was as much dependent on deficient air movement as on high temperature. In Table 3 it will be seen that the mean velocities in winter and summer were only 17 and 21 feet per minute respectively, or not much more than half those observed in boot and shoe shops. A velocity of 25 feet or more was observed only in 18 to 38 per cent. of the observations made. It might be thought that these low velocities were dependent on some peculiarity in the construction of the potters' shops, but such is not the case. They were due chiefly to the wish of the potters themselves, as was proved

TABLE 2.—FREQUENCY OF OCCURRENCE OF DRY KATA COOLING POWERS

Dry Kata Cooling Power	Boot and Shoe Shops		Printing Works		Potters' Shops		Cotton Weaving Sheds	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
	%	%	%	%	%	%	%	%
Below 4.0	0	8	3	26	3	29	6	28
4 to 4.9	1	10	5	26	18	*34*	*44*	*51*
5 to 5.9	4	19	30	*39*	*40*	26	36	19
6 to 6.9	28	*28*	*35*	9	24	8	13	2
7 to 7.9	*35*	20	22	0	12	2	1	0
8 to 8.9	18	9	5	0	3	1	0	0
9 or more	14	6	0	0	0	0	0	0
Median cooling power	7.4	6.4	6.2	4.8	5.6	4.5	5.0	4.3
Total observations	377	276	216	66	289	433	247	187

TABLE 3.—FREQUENCY OF OCCURRENCE OF VARIOUS AIR VELOCITIES

Air Velocity	Boot and Shoe Shops		Printing Works		Potters' Shops	
	Winter	Summer	Winter	Summer	Winter	Summer
ft. per min.	%	%	%	%	%	%
Under 10	13	18	1	6	3	4
10 to 14			23	*30*	28	13
15 to 19			21	17	*32*	*24*
20 to 24			*25*	16	19	21
25 to 30	*21*	15	13	11	13	16
31 to 35	17	13	7	9	3	7
36 to 40	14	14	2	2	1	6
41 to 51	19	*20*	4	3	1	3
52 to 74	9	10	3	4	0	5
75 or more	7	10	1	2	0	1
Median air velocity	35	37	20	18	17	21
Total observations	373	273	216	66	289	463

TABLE 4.—OPEN WINDOWS AT POTTERS' SHOPS IN RELATION TO TEMPERATURE

Average Temperature Outdoors	Average temperature in Shop	Percentage of Windows			Percentage Window Space Open
		Shut	Half Open	Open	
° *F.*	° *F.*				
36.3	66.5	88	8	4	8
46.3	69.8	78	21	1	11
55.4	72.2	48	42	10	31
65.6	76.0	19	61	20	51
73.5	80.4	10	57	33	62

by a very simple method. On every occasion on which we made observations in the shops, we carefully noted the number of windows which were (*a*) closed completely, (*b*) half open, and (*c*) fully open. Most of the windows were of the usual hopper type, which could easily be fixed in any of the positions mentioned, but if any of them were permanently shut up, we ignored them altogether.

In Table 4 are recorded the average results obtained in one of the sets of shops investigated—namely, those provided with "leaf" and "draw-out" stoves. When the outdoor temperature varied from 30° to 39.9° (mean, 36.3°), the shop temperature averaged 66.5°. This was too cold for the potters, for we see that on an average they opened only 4 per cent. of their windows fully, and 8 per cent. of them to half their extent. Roughly speaking, it may be said that the open space is only half as great when the windows are in the half-open position as when they are in the open position, so that in the present instance only 8/2 + 4 = 8 per cent. of the total available window space was opened up. At an outdoor temperature of 40° to 49.9° the shop temperature averaged 69.8°, but even this temperature was not considered too hot by the potters, and they opened only 11 per cent. of their window space. At shop temperatures of 72.2°, 76.0° and 80.4° (corresponding to outdoor temperatures of 55.4°, 65.6° and 73.5°), however, they evidently began to think that it was rather too warm, for they opened 31, 51 and 62 per cent., respectively, of their window space. Yet even a shop temperature of 80.4° could not have affected them very much, for they still kept 10 per cent. of their windows entirely shut, and 57 per cent. of them half shut. The probable reason is that they come to the works at the age of 14, and they get so acclimatized to the high temperature that they feel uncomfortable without it. It should be stated that the hopper windows are so constructed that they cause no draft when they are in the half-open position, though they may do so when they are fully opened.

In the shops provided with "dobbin" stoves and "chamber" stoves, the potters did not keep the workrooms quite so warm, but they seemed to prefer a temperature not much below 70°.

The effect of opening the windows was to increase the air currents somewhat, though not as much as might be expected. When the outdoor temperature was at 30° to 50°, the air velocity in the shops averaged 18 feet per minute, while at 50° to 60° it was 21 feet; at 60° to 70°, 24 feet; and at 70° to 80°, 29 feet. The velocity of the outside air at these temperature intervals was 204, 235, 179 and 176 feet, respectively.

It is pointed out by Vernon and Bedford that in considering the *effective* velocity of the air currents impinging on the skin surface of an actively engaged manual worker, an additional factor has to be taken into consideration—namely, the actual body movements made. Supposing that a potter, who is working in an air current of 20 feet per minute, has to move his body at an average rate of 30 feet per minute in order to carry out his industrial operation, it follows that the effective air velocity, so far as he is concerned, is somewhere between 10 feet per minute (when he is moving in the direction of the air current) and 50 feet (when he is moving against it), instead of 20 feet. As his movements are made at an irregular rate, and as the air current is probably variable in direction and

strength, it is impossible to fix the effective velocity closely, but perhaps it is, in most potters, about midway between the extreme possible limits.

The cooling effect of moving air operates chiefly on the face and head, for the rest of the body, with the exception of the forearms, is normally covered with clothes. Hence the observations made related to the *head movements* of the workers, rather than to the body movements. The method of procedure was a rough and ready one, but it gave consistent results, and was less difficult to carry out than a more accurate method would have been. If, for example, the movements of a man engaged in making plates on a jolly (a rapidly revolving wheel) were under investigation, a few rough measurements of the range of his chief movements were first made with a 2-foot rule, which the observer held in one hand. In the other hand he carried a stop watch. On starting the watch he estimated by eye (giving an occasional glance at the 2-foot rule to serve as a standard) the number of feet through which the potter moved his head. After two minutes the watch was stopped, and the number of feet moved in a minute was calculated. Each investigator made two or more sets of observations on each worker, and took a mean. A sample series, made upon plate makers, will show the kind of consistency attained. The observations in italics were made by one investigator, and those in plain figures, by the other.

Head Movements of Plate Makers

	Ft. per Min.					Mean	
Male No. 1	*28*	*24*	30	29		=28	30 ft. per min.
Male No. 2	*32*	*34*	26	25	24	=28	
Male No. 3	*28*	*27*	30	29		=29	
Female No. 1	32	37	32			=34	

It will be seen that the men showed almost exactly the same extent of head movement, while the woman moved rather more than they. The individual workers were usually fairly consistent, but not always. For instance, four saucer makers in one shop showed head movements of 40, 43, 43 and 45 feet, respectively, while a fifth moved only 29 feet per minute.

A large number of observations were made on various classes of workers, and it was found that in most of them the head movements amounted to 20 or 30 feet per minute. On the other hand the mould runners, who have to carry the ware to and fro between the potters and the drying stoves, averaged 70 feet per minute.

Workshops with Abnormal Atmospheric Conditions

In several of the industries investigated, the nature of the industrial operations is such as to necessitate some departure from normal atmospheric conditions. Especially is this so in certain textile processes, such as the weaving of cotton and linen goods, for with many classes of material it is important to have a hot and humid atmosphere; otherwise breakages of the yarn are much more frequent, and the quality and quantity of the material woven are depreciated. The need for hot and humid air is recognized by the Factory Acts, for the regulations allow artificial humidification in cotton cloth factories so long as the wet bulb temperature does not exceed 75°, and so long as there is a difference of at least 2° between the wet and dry bulb temperatures at 70°, a difference of 3.5° at 75°, and one of 5° at 80° (dry bulb). In flax spinning, linen weaving, and worsted spinning, even more trying conditions are permitted, as a difference of only 2° between wet and

dry bulb temperatures is required, whatever the temperature. It is true that the manufacturers seldom avail themselves of the extreme latitude allowed by law, but observations made in 140 flax spinning rooms in Irish mills showed an average dry bulb temperature of 80.3°, and a wet bulb temperature of 75° (5).

Cotton Weaving.—If the temperature of a shed or mill is systematically kept at a high level, it is obvious that the cooling power of the air must be greatly reduced, unless the amount of air movement is correspondingly increased. Hence kata-thermometer observations are particularly important. A large number of observations have recently been made by Wyatt (6), relating to cotton weaving sheds, and the principal results obtained are summarized in Tables 5 and 2. Seven large sheds were tested in winter, and seven in summer, about thirty observations being made at each season in each shed. It will be seen that the dry cooling power averaged 5.2 in winter, and 4.3 in summer, except in one shed. In this the air was not artificially humidified as it was in the others, and a cooling power of 5.0 was observed. The deficient cooling power of the sheds is chiefly due to the high temperatures, for the air currents had an average velocity of 26 feet per minute, which is more than that observed in potters' shops and printing works, though less than that in boot and shoe shops. The wet kata cooling power was even more deficient than the dry kata power, owing to the humidity of the atmosphere. We see that it averaged only 14.9 in the winter and 13.3 in the summer, except in the unhumidified shed, where it showed the nearly normal value of 17.3.

The frequency distribution of the dry kata cooling powers is recorded in Table 2. It will be seen that in winter time half of all the values were below 5, and in summer time, 28 per cent. of them were below 4. Only 14 per cent. of the winter observations and 2 per cent. of the summer observations reached a value of 6.

The extremely deficient cooling power of the air in the weaving sheds during the summer months caused many complaints among the weavers, and there can be no doubt that they were fully justified in making them. Even if the exigencies of the industrial operations required a hot and humid atmosphere, this was no excuse for the low air velocities. By means of suitable ventilating fans they could have been greatly increased. Wyatt has suggested another and very ingenious method of attaining the same end. He found that the air movement in the vicinity of the weaver could be much increased by fastening strips of material of various widths to the loom. The most satisfactory method consisted in attaching the ends of a stiff canvas, 3 inches wide, to the two metal supports on the heald roller. A horizontal board was used to deflect the air toward the weaver, and in consequence the cooling power of the air was raised from 4.6 to 9.0, corresponding to an increase in air velocity from 21 feet per minute to 252 feet.

Laundry Trade.—In addition to the textile industries, where a high temperature is desirable in the interests of production, there are other industries in which it can scarcely be avoided, because of the heat incidental to the carrying out of certain of the processes. This is certainly true of laundry work, according to the observations of Miss Smith (7). A large modern laundry was investigated for a week in summer and in winter, the observations being usually made at hourly intervals during the

course of the working day. The extreme variations in the mean dry bulb temperature, the mean dry kata cooling power and the air velocity, calculated from these observations, are recorded in Table 6. It will be seen that in November the cooling power did not fall below 4.5 in any of the rooms investigated, though the temperature rose as high as 80°. This was owing to the considerable degree of air movement, which was induced largely by ventilating fans. The summer observations were made during hot weather, and in consequence the temperature in the laundry rooms was often over 80°, and sometimes over 90°. The cooling power fell to less than 3 in four of the five rooms investigated, in spite of the fact that there was usually a fair amount of air movement, and occasionally a considerable amount.

Observations lasting one or more days were made in the hand-ironing and calender rooms of ten other laundries. In only three of the hand-ironing rooms, and one of the calender rooms, did the cooling power reach the standard value of 6, and in several of the rooms it never rose much above 3, while it fell to less than 2 in the course of the day. This was chiefly due to the high temperatures, as the degree of air movement was usually fairly good. Still, it was by no means sufficient, considering the high temperatures, and if these high temperatures are really unavoidable, they must be compensated for by greatly increased artificial ventilation.

TABLE 5.—MEAN ATMOSPHERIC CONDITIONS IN COTTON WEAVING SHEDS

Sheds Investigated	Number of Operatives	Number of Observations	Dry Bulb Temp.	Wet Bulb Temp.	Dry Kata	Air Velocity	Wet Kata
			° F.	° F.		ft. per min.	
7 humidified sheds in winter	278	35	70.7	65.9	5.2	26	14.9
6 humidified sheds in summer	278	27	74.7	70.0	4.3	26	13.3
1 unhumidified shed in summer	260	24	72.1	62.8	5.0	28	17.3

TABLE 6.—DIURNAL VARIATIONS IN ATMOSPHERIC CONDITIONS AT LAUNDRY

Place Investigated	Observations in November			Observations in August and September		
	Dry Bulb Temp.	Dry Kata	Air Velocity	Dry Bulb Temp.	Dry Kata	Air Velocity
	° F.		ft. per min.	° F.		ft. per min.
At folding table	68.5 to 75.2	7.5 to 4.8	43 to 94	66.0 to 79.5	8.6 to 4.3	66 to 113
At ironing table	72.0 to 76.0	6.0 to 4.6	35 to 71	73.0 to 84.9	5.8 to 2.4	24 to 81
Press room	73.0 to 80.0	6.8 to 4.5	82 to 141	73.9 to 93.0	6.4 to 1.3	52 to 120
Calender room	—	—	—	69.0 to 83.0	6.4 to 2.6	8 to 52
Collar packing room	—	—	—	70.0 to 86.0	5.4 to 2.5	28 to 56
Air outside (at noon)	56.5	16.2	289	76.7	6.8	181

Conclusion

Probably it will be admitted that the observations described, though they relate to comparatively few industries, are sufficient to indicate the value of the kata-thermometer in industry. It is evident that systematic investigations ought to be made in all our chief industries, in order that it may be possible to estimate and compare the atmospheric conditions to which the various classes of workers are subjected. If the conditions observed are expressed in terms of temperature and air velocity as well as in cooling power, it will be possible to see at a glance in what direction improvements of the conditions ought to be attempted. It will no longer be

sufficient for a manufacturer to explain that his industrial process requires a high temperature or a humid atmosphere, if we find that he is making no attempt to counteract these requirements by the establishment of greater air movement. Again, if we find that in some of the workshops of an industry the atmospheric conditions are reasonable, and are effected without loss of efficiency, we shall be justified in expecting other and less satisfactory workshops to conform to similar standards.

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THE PREPARATION OF HATTERS' FUR: A CHEMICAL STUDY OF THE CARROTTING PROCESS*

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THE process of preparing fur for felting purposes by treatment with a mercurial solution has been common practice for a great many years, and dates back to the beginning of the seventeenth century in France. In early times the procedure was kept strictly secret and it was given the name *sécrétage*. During the eighteenth century the knowledge was carried to England and the secret was communicated to a number of workmen, who gradually passed it on. In England and America the process of *sécrétage* is called carrotting, and the solution used for this purpose is known as the carrotting solution, or simply the carrot.

Despite its highly poisonous character, mercury continues to be used for this purpose, and clinical records show a large number of cases of chronic mercurialism among workers in the felt hat industry. Efforts have been made to substitute a non-poisonous metal for mercury but they have not met with success. The present investigation was undertaken with the idea of studying the carrotting process and attempting to replace mercury by an innocuous substance.

To indicate the rôle of carrotting in the preparation of felt hats, the following brief summary will suffice:

Preparation of the Carrot.—Although there is variation among hatters' furriers, the ordinary carrotting solution is essentially made by dissolving one part of mercury in five parts of strong nitric acid, and diluting the resulting solution to the desired specific gravity, 10° to 13° Bé. In dissolving the mercury, large quantities of oxides of nitrogen are evolved, and precautions must be taken to prevent the escape of these gases into the working rooms. It is stated in the French literature that the solution for white carrotting is made in the proportion of one part of mercury to three of nitric acid, but this modification is not commonly used in America.

Preparation of the Hat-Bodies.—The skins of rabbit, hare, and nutria are opened, shaken out, and brushed, in order to remove dirt and loose hair; the long hairs are then removed by plucking, leaving the short soft hairs, called the fur. The brushed fur is treated with the carrot, which is applied by means of a stiff brush, manipulated by hand or by machine. The excess of the solution is drained away and the pelts are then dried. The drying may take place at a high temperature (120° to 150° C.); or at a low temperature (30° C.), by circulating a current of warm dry air over the pelts. In the first case the drying is complete in less than one half-hour, but the fur becomes yellow in color owing to the action of the hot nitric acid. This quick method, known as yellow carrotting, is very extensively used in America. The second method, called white carrotting, requires a much longer time, but in this case no discoloration is observed. After they are dry, the pelts are again brushed to remove dirt and loose hairs. The brushed pelts are then fed into the cutting machine, where the fur is removed in such a way that it retains its original form. The skin, which is completely shredded, is collected and sent to glue factories. The cut fur is kept in bags until used, and may be stored thus for an indefinite period.

The cut fur is fed into the blowing machine, in which it is picked apart and tossed about in a current of warm air in order to remove dirt, and to separate the coarse hairs and matted parts. The blown fur is weighed and fed into the forming machine in which, by suction, it is drawn against a revolving copper cone. This cone is perforated and measures 27 by 29 inches. The cone, covered with fur,

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is removed from the machine and wrapped loosely in a wet cloth. The whole is then immersed in water for a short while, and the cover cloth and formed hat are removed from the cone. The loose felt is subjected to the forming and sizing process, in which it is alternately immersed in hot water, and kneaded on a wooden plank. The felt thus becomes more compact, and is shrunk to the desired size. The subsequent steps differ with the kind of hat which is to be made, but as far as carrotting is concerned, the finishing processes need not be considered.

The aim of the present work is to study the carrotting process, and to find some non-toxic material which will produce the same effect as mercury. A number of salts of the common metals have been tried as carrots, but the felt produced in this way was always greatly inferior to the control mercury-carrotted specimen. The data and list of solutions used are shown in Table 1.

The change which is brought about during the carrotting process is quite essential for the successful felting and shrinking of the fur, and this has been the subject of numerous investigations. The very first workers noted a change in the appearance of the hair after carrotting. Examined under a microscope, the natural hair appears smooth in outline; after carrotting, the epidermal layer of cells is opened out and the edge of the hair appears rugged like the teeth of a saw. The difference is illustrated in Figures 1 and 2.

It is to this slight change that the beneficial action of the carrot is attributed. According to Sabouraud, quoted by Chaplet, "the effect of 'sécrétage' is primarily to soften and render supple the keratin which forms the sheath of the hair; secondly, to loosen slightly the cortical cells, which are tightly fitted together, in such a way that they remain in place but can be dissociated much more readily by crushing; and finally, in certain cases, to modify the color by acting on the hair pigments."

Hillairet concludes from his work that the interlacing during felting is not due to the development of epithelial inequalities, but chiefly to the extreme flexibility of the fibers after the destruction of their sheath. The subsequent immersion in hot water, and the resulting tendency to twist, assist considerably in the intrication of the fibers under the influence of pressure. This explanation appears to be satisfactory, and has been generally accepted.

In addition to this change, carrotting gives the fur an added weight, which makes the blowing process much more effective. Whereas it is very difficult to blow untreated fur, the added weight of the carrotted fur is an advantage at this point. There is little doubt that any metallic salt which produced a satisfactory carrot, would give the same effect in blowing, for the latter is purely mechanical.

The chemistry of carrotting has been investigated by several French workers, and a number of ideas have been given concerning the "active principle" of the mercury carrot. Hillairet regards the mercury as superfluous and attributes the action solely to nitrated and nitrosated compounds formed by the action of nitric acid and of the nitrous acid which is liberated in a nascent state in the presence of the organic matter. Others have suggested that the mercuric nitrate penetrates into the hair and simply prevents the acid from acting too vigorously. It is certain that nitric acid alone, or with certain other metallic nitrates, when applied in the usual way fails to give a satisfactory carrot, since the resulting felt is inferior in quality (Table 1).

Nitrous acid appears to be an important factor in the process and may originate in two ways: (1) Undoubtedly considerable quantities of mercuric nitrite are formed by the solution of mercury in strong nitric acid; (2) large quantities of nascent nitrous acid are formed by the action of nitric acid on organic matter. It is not unlikely that mercuric salts catalyze the decomposition of nitric acid in the presence of organic matter, and in this way facilitate the formation of nitrous acid.

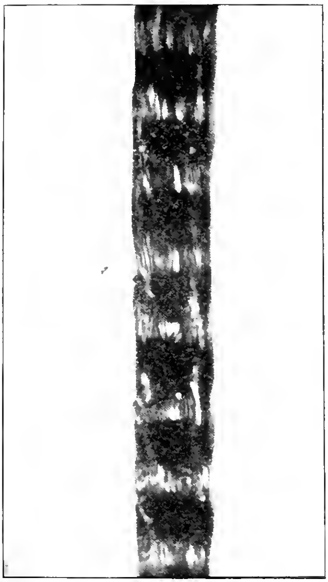

Fig. 1.—Natural hair x 1350.

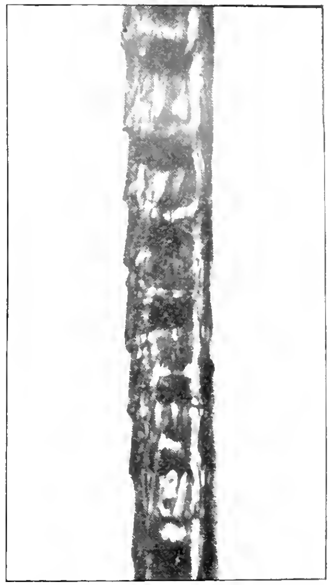

Fig. 2.—Mercury-carrotted hair x 1350.

Résumé of Previous Work

France.—More than one hundred years ago attempts were made in France to find a suitable non-mercury carrot. As early as 1817, Guichardière presented before the Société d'Encouragement des Poils Secrétés sans Mercure a method using sulphuric acid. In the same year, Malard and Desfosses were granted a patent for the use of an alkaline carrot containing two parts of soda to one of quicklime. Bredut (1), who directed the practical tests, stated that the "forming" of fur carrotted in this way was exceedingly slow, and the results were very irregular.

In 1869 Hillairet (2) proposed a non-mercury carrot based on his idea that mercury was not essential, and that the products of the decomposition of nitric acid were sufficient. As an organic substance to facilitate the decomposition he employed sugar or starch[1], or, on a

[1] The procedure of Hillairet is practically the same as that given in a communication from J. L. Roessler in Paris, which was patented in England by J. H. Johnson, in 1867. This patent "consists in substituting for the preparation of mercury, carbohydrates, or other substances capable of decomposing nitric acid into nitrous acid; *e.g.*, raw or refined sugar, gum, and starch."

larger scale, molasses, since it was cheaper.

According to this procedure two solutions are prepared: A, containing molasses: B, containing nitric acid.

White Carrot

		Kg.
A.	Molasses	8.5
	Water	14.0
B.	Nitric Acid (38° Bé.)	12.0
	Water	12.0

Yellow Carrot

		Kg.
A.	Molasses	8.0
	Water	19.0
B.	Nitric Acid (38° Bé.)	16.4
	Water	16.0

Solution A is applied first, followed immediately by B, and the pelts are dried in the usual manner. When dry the excess of molasses is removed by washing with water, and after brushing, the pelts are allowed to dry very slowly. After this the normal procedure is followed, and according to the literature a very good felt results. Even though a good felt were obtained (which seems doubtful), this modification would not meet with success on account of the increased amount of labor necessary.

In 1884 Grossot (3) patented the use of a mixture containing creosote oil, alcohol, water, and nitric acid. In 1887 Dargelos (4) patented the use of cold dilute aqua regia, containing one part of nitric acid to three parts of hydrochloric acid. In 1890 Fabre (5) patented the use of a mixture of turmeric, alum, salt, and sulphuric acid.

In 1891 Burg (6) obtained two patents including more than ten different carrots. In the latter are included nitric, sulphuric, oxalic, and acetic acids, and the nitrates or sulphates of potassium, zinc, ammonium, copper, iron, antimony, sodium, tin, and aluminum.

In 1892 to 1893 Lussigny (7) patented a white carrot consisting of a caustic alkali, and a yellow carrot consisting of carbon and nitric acid. A dilute solution of potassium hydroxide, it is stated, gave the best results, and is said to have been employed with favorable results by a French manufacturer. The latter failed in 1897, on account of the fact that other firms discredited his product. It is stated by Levitzky (8) that the procedure of Lussigny was used with success in Moscow, and by 1907 was being employed in a large number of Russian workshops. A good account of the French attitude and a summary of previous work is found in Chaplet's article (9).

At the International Congress of Hat Workers in 1907, the procedure of Ronjat (10) was received with great favor. This consists in the substitution of nitrates of tin for mercuric nitrate, with or without the addition of sodium nitrite. The statements of Ronjat (quoted by Martial, 11) seem rational and logical, apparently representing the best work that has been done on the subject. The result of a single trial of tin is reported in Table 1, and although a poor felt was obtained, this was not taken too seriously since it must be remembered that each step in the felting process, as now carried out, has been designed to give the best result with a mercury carrot, and undoubtedly modifications will be necessary to suit a change in the carrot.

England.—A number of patents have been granted in England for non-mercury carrotting solutions, but these have been chiefly of French origin. At the International Congress in 1912 Tylecote (12), in a report on mercurial poisoning, referred to the modifications of Hardcastle, using the nitrates of iron and zinc, zinc chloride, and nitrous acid. In the same year Lloyd and Gardner (13)

reported a number of analyses showing the mercury content of hats, hat-bodies, and fur at various stages in the process of hat making.

In 1914 a patent was granted to L. F. Paris (14) for the use of sodium nitrite, sodium hypochlorite, zinc chloride, and nitric and hydrochloric acids. This combination of many active substances is certainly too destructive to be used in the ordinary manner, and no report of its use has been found further than the claims in the patent itself.

United States.—Although little work on non-mercury carrots has been published in America, a great many clinical investigations of mercurial poisoning have been made. The first comprehensive work was that of Dennis in 1878 (15). The report of Mrs. Linden W. Bates (16), and that of Louis Harris (17), are regarded as the best in recent years.

In 1917 Braun (18) patented a method consisting in the use of a hot aqueous solution of sodium carbonate. The patent claims that cut fur can be used, and that the hides can therefore be saved and used as cheap leather. In the ordinary procedure the hides are completely shredded and can be used only for the preparation of glue. Although very definite directions are given in this patent, the results claimed could not be duplicated in a large series of trial experiments. Several variations were attempted using sodium carbonate, and soda-ash, but the results were never satisfactory.

Experimental Work

There were two problems to be considered in connection with this series of experiments: first, the selection of chemical reagents to be used; and second, the choice of a suitable standard for comparison. In selecting the substances to be tried as mercury substitutes, several courses were followed: An attempt was made to replace mercury by another substance which would act in the same manner; solutions recorded in the patent literature were duplicated; and new combinations were tried, either at hazard, or in accordance with theories of the mechanism of carrotting.

Assuming that mercury dissolves in nitric acid according to the equation.

$$3Hg+8HNO_3=3Hg(NO_3)_2+4H_2O+2NO,$$

the ordinary mercury carrot prepared by dissolving one part of mercury in five parts of nitric acid (40° Bé.) would contain one gram-equivalent of mercuric nitrate (162 gm.) to three and one-half equivalents of nitric acid. In a series of tests using other metallic nitrates with nitric acid, the ratio of one equivalent of metallic salt to three and one-half equivalents of nitric acid was preserved, in order to vary the nature of the carrot as little as possible. In actual practice the mercury carrot is diluted to a specific gravity of 12° to 13° Bé. (1.090 to 1.098), and in accordance with this procedure the test solutions were in most cases diluted to 13° Bé.

In selecting the metal nitrates to be used in replacing mercuric nitrate, the Mendeléeff periodic system was found useful, since in this table the elements with similar properties occur in the same groups. From this, zinc and cadmium seemed promising, but the actual results with these metals were discouraging. Using the horizontal series as a guide, lead and bismuth were suggested, but unsatisfactory results were also obtained with these nitrates. Although the felt obtained by substituting lead was of an inferior quality, it was judged as the

best of the non-mercury carrotted specimens. This is rather unfortunate since the poisonous character of lead salts precludes any attempt to perfect a lead carrot.

In addition to the nitrates of the metals already mentioned, salts of a number of common metals were tried out on a small scale in the laboratory, and a few on a larger scale in the factory of the John B. Stetson Company of Philadelphia.[2] The results of these tests are shown in Table 1.

One of the most important considerations in carrying out this series of experiments was the choice of a suitable standard, since no simple comparative method was available. The ideal way would be to carrot the pelts with an experimental solution, convert them into felt in the usual manner, and compare the experimental felt with a control mercury-carrotted specimen. The objection to this method is the expense involved, since the ordinary blowing machine cannot be successfully operated for a charge of less than 1½ to 2 pounds of fur, representing from fifty to sixty pelts. It was therefore advisable to find a means of making preliminary tests and of reserving the large scale tests for a small number of the more promising solutions.

As a preliminary method, the microscopic examination of the dry hairs affords an easy means of following the experiments, but in general the results are not reliable, because the changes are slight and the difference between individual hairs is great. Since the indications obtained by this method were not in good agreement with those obtained by the first method, the results of the actual felting were accepted as final, and the microscopic examination was used merely as a preliminary step.

Technic and Experimental Results

The series of experiments was divided into two groups: one, executed in the plant of the Stetson Company; and another, carried out on a laboratory scale at the Harvard Medical School. In the first case the trial carrotting solution was substituted for the mercury carrot in the ordinary routine, and the whole procedure was completed in the usual way. The behavior of the trial specimens was carefully recorded and compared with that of mercury carrotted fur. In Table 1, the behavior during shrinking, the time of shrinking, and the quality of the felt obtained from a series of experiments, are recorded.

TABLE 1.—RESULTS OF EXPERIMENTS WITH VARIOUS TEST SOLUTIONS*

	Yellow Carrot			White Carrot		
Test Solution	Shrinking	Time	Felt	Shrinking	Time	Felt
		hours			*hours*	
1	slow	2 1-2	fair	fair	2	fair
2	slow	2 1-4	poor	very slow	3	very poor
3	fair	2	fair	fair	2	fair
4	fair	2	fair	fair	2 1-4	fair
5	fair	2 1-4	fair	slow	2 1-2	poor
6	fair	2	fair	fair	2 1-6	poor
7	fair	2	fair	slow	2 1-4	poor
8	very slow	3	poor	very slow	2 5-6	poor
9	fair	2	fair	fair	2	poor
10	good	1 3-4	good	fair	2	fair
11	very good	1 1-2	very good	very good	1 2-3	very good
12	good	2	fair	impossible	—	—
13	fair	2h. 5m.	poor	poor	2 5-6	fair
14	fair	2h. 5m.	good	fair	2 3-4	good

*In the comments made by the Stetson Company, the standard for comparison is the mercurial carrot in ordinary use in that factory. The time required for shrinking with this carrot is between one hour and thirty minutes and one hour and forty minutes. They considered that solution No. 14—namely, copper dissolved in nitric acid, and

[2] The writer wishes to acknowledge his indebtedness to the John B. Stetson Company for its cooperation in carrying out a number of practical tests. They were kind enough to place at his disposal the records of their experiments, and to assist and advise in many ways.

Preparation of the Test Solutions

1. One part of lead was dissolved in four parts of nitric acid (40°Bé.) previously diluted with water, and the resulting solution diluted to 13°Bé.
2. One part of zinc was dissolved in six parts of nitric acid (40°Bé.) previously diluted with water, and the resulting solution diluted to 13°Bé.
3. One part of zinc was dissolved in twelve parts of nitric acid (40°Bé.) previously diluted with water, and the resulting solution diluted to 13°Bé.
4. One part of tin was treated with four parts of nitric acid (40°Bé.) previously diluted with water, and the resulting mixture, which contained a white precipitate of meta-stannic acid, was diluted to 13°Bé.
5. Two parts of potassium permanganate were dissolved in thirty-eight parts of water, and one part of nitric acid (40°Bé.) and one part of concentrated sulphuric acid were added. The resulting solution had a specific gravity of 11.5°Bé.
6. One part of cupric nitrate crystals ($Cu(NO_3)_2.3H_2O$) was dissolved in water, and three parts of nitric acid (40°Bé.) were added. The resulting solution was diluted to 13°Bé.
7. Three parts of cadmium nitrate crystals ($Cd(NO_3)_2.4H_2O$) were dissolved in water, and seven parts of nitric acid (40°Bé.) were added. The resulting solution was diluted to 13°Bé.
8. One part of soda-ash was dissolved in eighty parts of water.
9. Pure nitric acid was diluted to a specific gravity of 13°Bé.
10. One part of mercury was dissolved in ten parts of nitric acid (40°Bé.), and the resulting solution diluted to 13°Bé.
11. Control experiment: One part of mercury was dissolved in five parts of nitric acid (40°Bé.), and the resulting solution diluted to 13°Bé. This is the ordinary mercury carrot.
12. Four parts of bismuth subnitrate were dissolved in nine parts of nitric acid (40° Bé.), and the resulting solution diluted to a specific gravity of 13°Bé.
13. One part of cobalt carbonate was dissolved in three parts of nitric acid (40°Bé.), and the resulting solution diluted to a specific gravity of 13°Bé.
14. One part of copper and one part of zinc were dissolved in eleven parts of nitric acid (40°Bé.), and the resulting solution diluted to 13°Bé.

Several experiments were made using the sodium carbonate procedure patented by Braun (18), but no successful results were obtained. In these experiments, cut fur was treated with hot aqueous sodium carbonate solution for definite periods of time (thirty to forty-five minutes), centrifuged to remove excess of the carrot, formed, and hardened in the usual way. In general the shrinking was very slow and the felt poor. A similar experiment with the regular mercury carrot applied to cut fur, gave a very poor felt.

On a small scale, the following technic was employed: The brushed skins, which had been crudely clipped by hand, were impregnated with a test solution by means of a small brush, and dried in a small gas oven at temperatures varying from 40° to 120°C. After they were dry, the skins were brushed and allowed to stand at room temperature for several days.[3] Specimens of fur were then cut from the back and sides and examined under high magnification. For comparison, natural hair and mercury-carrotted specimens were used. By this method the carrots could merely be arranged into large groups; there was no accurate means of distinguishing between individuals within the groups.

To denote the various types of results, four groups were made, corresponding to the brief descriptions: (1) good; (2) fair; (3) fair to poor; (4) poor. These terms are indefinite, but the inaccuracy of the method does not permit any more definite statements.

zinc oxide dissolved in nitric acid—gave the best results in both yellow and white carrot, results promising enough to warrant further experimentation but not equal to the results obtained with ordinary mercurial carrot.

[3] In actual factory manipulation, carrotted pelts are usually stored at least three months before the fur is cut.

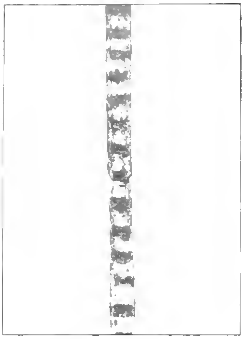

FIG. 3.—Natural hair.

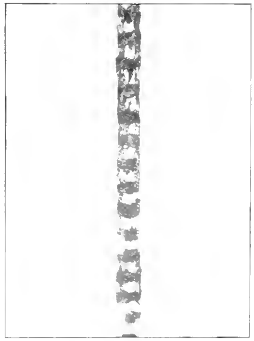

FIG. 4.—Tin-carrotted hair.

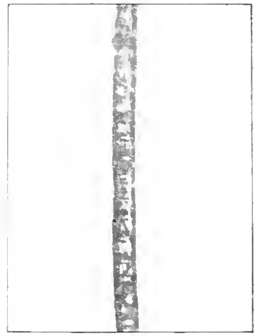

FIG. 5.—Cadmium-carrotted hair.

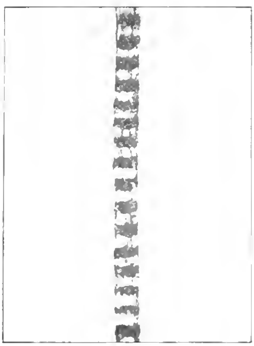

FIG. 6.—Silver-carrotted hair.

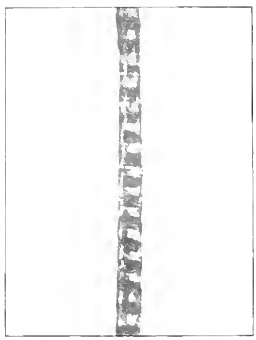

FIG. 7.—Copper-carrotted hair.

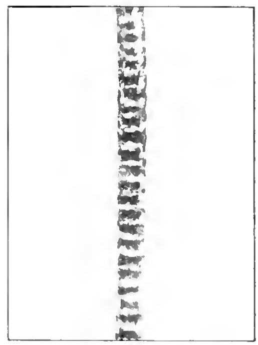

FIG. 8.—Mercury-carrotted hair.

Group 1.—Mercuric nitrate with nitric acid (control).

Group 2.—Nitrate of silver, copper, cadmium, lead, bismuth, cobalt, zinc, nickel, or aluminum with nitric acid.

Cupric chloride and formic acid.

Zinc and potassium sulphates with sulphuric acid (white carrot).

Group 3.—Stannic chloride with nitric acid.

Nitrate of iron, sodium, or calcium with nitric acid.

Nitric acid alone.

Sulphate of copper, cobalt, aluminum or manganese with sulphuric acid.

Sulphate or chloride of cobalt, copper, or manganese with hydrochloric acid.

Group 4.—Hillairet's procedure.

Mercuric chloride with hydrochloric acid.

Hydrogen peroxide, 3 per cent. solution.

Dargelos' procedure (dilute aqua regia).

Antimony sulphate and sulphuric acid.

Sulphuric, hydrochloric, formic or acetic acid, alone.

Potassium hydroxide.

Sodium carbonate.

Sodium stannite.

In certain cases photomicrographs were made of the specimens, and were found to be very useful for comparing results. The accompanying plates (Figs. 3-8) show a series of photographs of fur from four typical experiments, with photographs of natural hair and mercury-carrotted hair for comparison. In these experiments the ratio of one gram-

equivalent of metallic nitrate to three and one-half equivalents of nitric acid was used, and the yellow-carrotting procedure was followed.

The results of the experiments which have thus far been completed have shown that the problem of finding a non-mercury carrot is indeed an empirical one. Since each step in the present process of preparing felt, with a mercury carrot, has been gradually perfected during the course of several centuries, it is not surprising, nor discouraging, to find that the early attempts to replace this carrot are not successful. Undoubtedly the adoption of a new carrot will involve the alteration of numerous small details in the routine procedure, in order to produce a felt of the quality that is now produced.

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MINERS' NYSTAGMUS FROM THE POINT OF VIEW OF THE WORKMEN'S COMPENSATION ACT*

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THE publication of the "First Report of the Miners' Nystagmus Committee" (1) (referred to hereafter as the Report) brings into prominence the close connection between the incidence of certified cases of miners' nystagmus and the payment of compensation.

This aspect of the subject is dealt with in the present communication, and the data upon which it is based were collected by the writer for the use of the Committee. The expenses of the investigation were met by a grant from the Medical Research Council.

Stages of the Disease

The primary symptom and physical sign of the disease is a rapid and rotatory oscillation of the eyeballs occurring among coal miners who have been employed below ground for a considerable period of time, amounting, on an average, to twenty-six years. The condition may be either latent or manifest.

During the latent stage, which may persist throughout working life, although the objective oscillation of the eyeballs is present, the miner is unaware of his condition, and experiences no disability. The latent stage, which may be short or long, passes into the manifest stage either suddenly—following upon an accident or some concurrent illness, such as influenza—or gradually. At this stage surrounding objects appear to dance and revolve before the sufferer, and vision fails, particularly at night and for skilled work; at the same time mental irritation often develops with post-cranial headache and broken sleep. When the disease reaches this stage, continued work below ground becomes impossible.

Cessation of work underground for from six to twelve months is generally followed by the disappearance of all objective signs, and usually results in permanent cure, especially if the miner is suitably employed. If he returns to underground work, however, relapse may take place. But during this convalescent stage, especially when compensation has been established, the subjective symptoms already referred to may be converted into a well-marked and persistent neurosis.

Findings of the Committee

Before entering upon further discussion of the disease it will be well to refer to the main conclusions of the Committee, which are as follows:

1. The essential factor in the production of miners' nystagmus is deficient illumination. Other factors, such as position during work, accidents, alcoholism, infections, malnutrition, hereditary predisposition, and errors of refraction, are of secondary importance only, while depth of workings, thickness of seams, and the ordinary gaseous impurities in mine air have no direct influence on the disease.

2. The deficient illumination is due to the low illuminating power of the safety lamps generally used by coal miners, to the distance at which these lamps have to be placed from the objects at which the miner has to look, and to the great absorption of light by the

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coal and the coal-dust covered surfaces. In addition the effect of coal dust or dirt in obscuring the lamp glasses, the choking of the wire gauze chimneys, and the presence of moisture or low oxygen percentage in mine air, all reduce the light given by oil lamps; while failing voltage, poor bulbs, or lack of proper attention, have similar effects on illumination given by electric lamps.

3. Workers at the coal face are more affected than other underground workers, and this appears to be due to the unrelieved blackness of the coal and the greater need for accurate vision.

4. Distinct signs of nystagmus are present in a large proportion of coal miners, though only in a small proportion do the symptoms ever become so severe as to cause even temporary incapacity for work underground.

The Committee recommends that since incapacity due to nystagmus is rare among coal miners working with open lights, everything possible should be done to make the standard of illumination of the objects looked at by the miner equal to that of an open-light pit. This can be effected at the coal face and elsewhere either by greatly increasing (to about two or three candles) the illuminating power of safety lamps as ordinarily used, or by the use of an electric light capable of being fixed on a miner's head, belt, or other convenient position, so that the light is automatically brought nearer the working area and does not impair clear vision by shining directly into the eyes. At parts of the pit other than the coal face the visibility of objects can be greatly increased by whitewashing, as well as by the stone dusting now obligatory for the prevention of explosions. The Committee believes that by the application of these remedies miners' nystagmus of sufficient severity to cause disablement can, by degrees, be entirely prevented.

Incidence of the Disease

In Great Britain.—On May 22, 1907, miners' nystagmus was added to the schedule of industrial diseases in the Workmen's Compensation Act of 1906. For the period before that date no accurate information in regard to the prevalence of the disease is available. The number of cases receiving compensation has steadily risen since that year, taking a big jump in 1913–1914, when the definition of the disease was altered by the order of the Secretary of State, July 30, 1913, from the original description "Nystagmus" to "The disease known as miners' nystagmus, whether occurring in miners or others, and whether the symptom of oscillation of the eyeballs be present or not." Information relative to the incidence of cases since 1908 is embodied in Table 1, which has been taken from the Report, and in part is shown graphically in Figure 1.

In Other Countries.—In Germany, from 1908-1912, 18.2 per cent. of the invalidity claims on the Bochum Miners' Union were for nystagmus. The number of cases per 1,000 in the period from 1905-1909 was 3.29; from 1910-1913, 3.25. In 1913 owing to a decision of the Superior Court, by which it was held that only serious cases of nystagmus were entitled to compensation, the number fell to 1.81. Stassen (2), in Belgium, and Dransart (3), in France, estimate the rate of total incapacity to be about two cases in every thousand workmen. It may be taken that the total incapacity rate for the four countries—United Kingdom, France, Belgium, and Germany—is 0.2 per cent. of the men employed underground. In America, where the disease is not certifiable, the incidence is very small and, with the exception of a valuable summary of European literature by Hoffman (4), practically nothing has been written on the subject.

The number of men who show nystagmus on examination is much higher than 0.2 per cent. Stassen (2), who has examined 11,000 miners, gives the percentage rate as 24.2; other authors (5) give similar figures.

Economic Loss

The amount of compensation paid for all industrial diseases in the mining

industry in Great Britain has risen from £13,382 in 1908 to £371,071 in 1920. This increase has been almost entirely due to nystagmus, and it may be assumed that in 1920 nearly £300,000 were paid in compensation for this disease alone. The loss falls on workmen, employers, and the state. The workmen, to whom health and working ability are everything, are reduced from an active life and a position of comparative affluence to dependence on weekly compensation. Home comforts are lost, the children are turned out into the world sooner than they otherwise would be, and the family tends to become restricted. The employer pays £300,000 a year in compensation, loses his best workmen, and finds his coal output reduced. The state loses the coal output of 6,000 men, which with the sum spent on compensation may be estimated at £1,000,000 a year (6). The indirect effect of the shortage of coal on other industries must also be taken into account.

In Great Britain under the terms of July, 1921, upon which the coal stoppage was settled, the workmen's wages are regulated by the financial results of the working of the industry. The pre-war wage rates are taken as the standard; to these are added the costs of production other than wages, together with an agreed percentage for profit to the owner. If the total of these charges is less than the proceeds realized from the sale of the coal, 83 per cent. of the surplus is added to the previous wage and expressed in the form of a percentage upon the basis rates. Workmen's compensation payments are part of the cost of production, and accordingly increased compensation means a reduction of any surplus available for wages. It is, then, in the interest of all parties—state, employer, and workmen—that the compensation costs should be kept low.

TABLE 1.—SHOWING PERCENTAGE INCIDENCE AND NUMBER OF CASES RECEIVING COMPENSATION FOR THE FIRST TIME DURING THE YEAR, TOTAL NUMBER OF CASES RECEIVING COMPENSATION DURING THE YEAR, COST OF ALL INDUSTRIAL DISEASES, NUMBER OF MEN EMPLOYED UNDERGROUND, NUMBER OF CASES DISABLED IN THE MINING INDUSTRY, AND OUTPUT IN TONS PER UNDERGROUND WORKER PER YEAR

Year	Fresh Cases of Nystagmus		Total No. of Cases of Nystagmus	Cost of All Industrial Diseases £[1]	No. of Men Employed Underground	Accidents (1,000s)	Output in Tons per Man per Year
	Percentage Incidence	Number					
1908	0.05	386	460	13,000	783,000	137	334
1909	0.08	631	1,011	26,000	805,000	154	328
1910	0.11	956	1,618	42,000	834,000	166	317
1911	0.16	1,375	2,519	68,000	849,000	167	320
1912	0.16	1,376	3,195	85,000	865,000	167	301
1913	0.26	2,402	4,551	113,000	895,000	195	321
1914	0.32	2,774	5,992	164,000	835,000	179	318
1915	0.24	1,780			743,000		341
1916	0.20	1,626	not		782,000	not	328
1917	0.18	1,461	available		799,000	available	311
1918	0.24	1,917			783,000		291
1919	0.29	2,718	6,449	225,000	933,000	134	246
1920	0.29	2,865	7,028	343,000	978,000	134	235

[1] Home Office returns do not separate cost of nystagmus from other industrial diseases. Nystagmus is responsible for over 90 per cent. of this cost.

Effect of Unemployment.—After the coal dispute in 1921 several collieries experienced difficulty in finding work for all their employees. In one colliery, employing 650 men underground,

in which three cases had been certified in 1920, it was impossible to find work for 250 men when the pits restarted. Within six weeks eighteen of these 250 men were certified as disabled by nystagmus. Altogether twenty-three cases were certified between July and November 20, 1921, but there was not a single case from among the 400 men who returned to work when the pit started.

During the year thirty cases in all were certified from this pit. Assuming that each case costs the company £200, a liability of £6,000 was incurred in one year from nystagmus alone, a sum sufficient to pay a dividend at 6 per cent. on a capital of £100,000. In small companies a run of nystagmus cases such as this would cause serious financial embarrassment and might even lead to failure.

Effect of Reduced Wages.—Figure 2 shows the drop in the daily wage of the collier since March, 1921, and the monthly rate of incidence of miners' nystagmus in a district employing 20,000 men underground. The universal experience in the English coal fields is that there has been a great increase in the incidence of the disease following unemployment and reduced wages.

Influence of Compensation

The workmen and employer differ very widely in their opinions of the incapacity caused by nystagmus. The employer points out that little was heard of the disease until compensation could be obtained, and that even at the present time the disease is rare in America where no compensation is allowed. The colliery manager says that the sequel to giving a man notice is the production of a certifying surgeon's certificate of disability for nystagmus; that many men can and do work with nystagmus; but that the younger generation gives up work at once.

From January 1, 1920, the maximum compensation was increased from 25 to 35 shillings a week. This was followed by a great increase in the number of compensation cases, and in North Staffordshire the figures for the first quarter of 1921 were 40 per cent. greater than those for the corresponding period of 1920. The great increase in the amount of compensation paid for all industrial diseases in late years (see Table 1) is entirely due to miners' nystagmus.

Compensation also enters into the question of surface employment. If a miner afflicted with nystagmus is employed on the surface, he is entitled to half the difference between his present and his former average wage (the half difference not to exceed £1). The underground wage is higher than the surface wage and the employer may be called upon to pay as much as £1 in half difference in addition to the ordinary surface wage. It is undoubtedly true that many men pursue a "ca'canny" policy and make no honest attempt to do a good day's work. They make so many stipulations as to the kind of work which they can perform, and are so irregular in their attendance that the employer is forced to the conclusion that they are not worthy of employment, and prefers to pay full compensation rather than employ them on the surface where they will corrupt the morale of his regular workmen by the slack manner in which they perform the work.

Mr. Gillhespy (7), general manager of the Yorkshire Coalowners' Mutual Indemnity Company, in his evidence before the Workmen's Compensation Committee in 1919, stated that an ex-

amination by Dr. Moxon of a typical Yorkshire pit, employing 2,000 men, showed that from 25 to 38 per cent. (according to the grade of employment) of all men over 21 years of age working underground showed oscillation of the eyes. Every one of these men could obtain a certifying surgeon's certificate and be legally disabled. In the great majority of cases the oscillation of the eyes produces no incapacity, and should not in itself entitle the man to compensation. Mr. Gillhespy says that the result of the scheduling of the disease has been to increase the incidence from thirty in 1907 to 515 in 1918. Thus:

Question 5677: There is one cause and one cause only — that is the chief thing — to account for this difference, and that is compensation.

Question 5715: It follows from that, that the difference in numbers must of necessity import the element of ungenuineness? To this extent, that they were legally genuinely disabled, but not in fact disabled. Also, unless the law makes the definite assumption that men with nystagmus can work, and must work, on the surface at the end of say six months, and unless the law definitely fixes the reduction to be enforced in the compensation, employers will be helpless, as a man with nystagmus can always allege that he is unable to work even on the surface, and to ask an employer to prove a man's fitness is simply asking an employer to attempt the impossible. Now the next paragraph is why I am here. Looking at the subject from the point of view of the men themselves, up to 1907, 30 men per annum were disabled. Now 515 men are disabled. The 485 additional men (515 less 30) themselves sacrifice one-half the wages they might be earning. The men themselves in the aggregate are thus unquestionably much worse off than if nystagmus had never been added to the Schedule of the Workmen's Compensation Act. If the deduction is also made that the disability in each case has grown as much as the number of claims has grown, the amount lost by the men each year, in wages, is huge. That is why I have come here, Sir. I want to show you this, that nystagmus was put into the Schedule of the Act at the request of the men and for the benefit of the men.

Mr. Gillhespy's facts are indisputable; it is probable that 25 per cent. of all men over 21 working underground could obtain a certifying surgeon's certificate and be legally disabled. In the light of our war experience, however, it is necessary to take a broader view than the one expressed by Mr. Gillhespy.

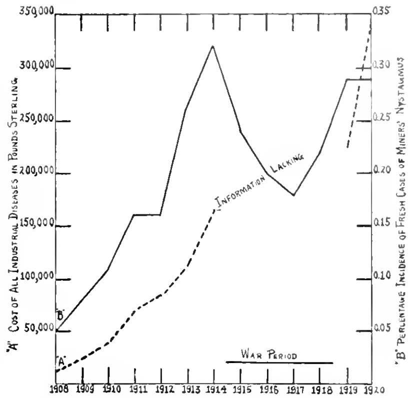

FIG. 1.—Showing incidence of fresh cases of miners' nystagmus (the figures given for the war years are only approximate), and cost from 1908 of all industrial diseases in the mining industry.

Psychoneurotic Factors.—War physiology has shown that many men placed in a position of danger or in uncongenial surroundings unwittingly react to their environment, and develop a neurosis of some form in order to escape. In the same manner the soldiers of industry who are unfit for or unsuited to their occupation develop a neurosis which brings them relief. If in addition to freedom from uncongenial work the release is associated with pecuniary advantages, the unconscious motive is doubly strong — one might even be tempted to say that it is quadrupled. It is quite common nowadays to hear colliers referring to the pit as the "hole"—a word of sinister meaning,

and a term which the writer does not remember hearing from a normal collier.

As an example of the development of psychoneurotic symptoms, may be instanced the prevailing belief among coal miners that permanent loss of sight results, if underground work is continued. This belief results partly from the failure of sight, which is common in the acute stages of the disease, and partly from the bad advice given by some medical men who threaten their patients with loss of sight if underground work is persisted in. In regard to this belief the Report states that:

> During its investigations the Committee has noticed the prevailing belief among coal miners that miners' nystagmus causes permanent damage to, or even total loss of sight, if underground work is continued after the onset of symptoms. This belief, which is entirely erroneous, has led to much unnecessary suffering and to the development of psycho-neurotic symptoms in many cases. The disablement resulting leads to great loss to the miners, and increases the charges on the industry and general public.

In the Report Dr. Rivers sums up the relationship between incidence of the disease and compensation as follows:

> The bearing of the psycho-neurotic aspect of miners' nystagmus upon the problems connected with compensation is more definite. We are here presented with a situation closely comparable with that presented by pensions in relation to the psycho-neuroses of war. There is no question whatever that the perfectly legitimate and praiseworthy measure by which those disabled as the result of the war should receive monetary compensation has through the highly complex nature of psycho-neurosis led to the actual production, and still more largely to the prolongation, of disability to work. Similarly, the great increase in the prevalence of disabilities from miners' nystagmus since the introduction of compensation shows that this measure, as legitimate and praiseworthy as the compensation of sufferers from the war, has through the complexity of the state produced a great increase in the prevalence of psycho-neurotic affections. It is quite certain that compensation has not increased the prevalence of nystagmus in the strict sense. It is solely through its action upon the psychical and psycho-neurotic aspects of the disorder that the increased frequency of disability has come about.

The leading article on the Report published in the *Lancet* (1922 *1*, 855) says: ". . . since the introduction of compensation the prevalence of disabilities from miners' nystagmus has vastly increased; there is no question whatever, as Dr. Rivers insists—and in this his contention will be bourne out by all who have to do with the problem of the neurasthenic war pensioner—that monetary compensation has led to the actual production, and still more to the prolongation, of disability to work." The reviewer proceeds to say that if the condition is largely due to a psychoneurosis "It is the man as much as the defective illumination that has to be put right. Immense, indeed, is the problem for industrial psychology that is brought before us."

American readers will recall the psychological experiments carried out in the later years of the war with the idea of fitting the right man into the right place. Although it is far from the writer's intention to advise the coal owners to engage a body of psychiatrists, it might be possible, with a slight extension of the school medical service, to attempt a vocational selection of boys about to leave school.

Intercurrent Illnesses

Many men quite honestly attribute the symptoms of the onset of disease to nystagmus. These men, who may have had a little inconvenience from a slight degree of nystagmus, persuade themselves that their present incapacity is due to

nystagmus. Other men knowingly take advantage of their legal right to compensation. The following case reports are cited as examples.

CASE 1.—J. B., aged 64, while proceeding to work, collapsed and was brought home suffering from heart failure and acute bronchitis, from which he nearly died. His relations became anxious and sent in a claim to the company for "bronchitis brought on by work in the pit." This claim was ignored. The doctor then noticed that the man had oscillation of the eyes, and as a result a certificate of disablement by nystagmus was eventually obtained. The appeal by the company, on the ground that although the man showed nystagmus it was not the cause of his incapacity, was dismissed by the medical referee who, while not disputing the employer's contention, maintained that as the man showed nystagmus the appeal must be dismissed and the man entitled to full compensation.

CASE 2.—W. T., aged 70, having a well-marked case of paralysis agitans, produced a certificate of disablement by nystagmus, when his real incapacity was due to disease.

CASE 3.—R. E., aged 55, had recently been discharged from employment. While trespassing on a field he fell into a ditch and hurt his knee. The accident was in no way caused by nystagmic vision. He first tried unsuccessfully to claim damages against the farmer. He then obtained a certificate for "beat" knee, against which the employers successfully appealed. His next move was to obtain a certificate of disablement from nystagmus, and as oscillation of the eyes was present no appeal could be made.

These cases and data afford some ground for the belief almost universally held by employers that many men have taken unfair advantage of the provisions of the Workmen's Compensation Act, and have used the compensation which they can legally claim as a form of unemployment pay or old wage pension.

CERTIFICATION

The process of certification is briefly as follows. Under the present regulations of the Workmen's Compensation Act, 1906, a man suffering from nystagmus must produce a certificate of disablement from the certifying surgeon of his district before he is legally entitled to compensation. The employer has the right of appeal against this certificate, within seven days of its receipt, to the medical referee, whose decision is final. If the employer does not appeal, the certifying surgeon's certificate is final, and the man is legally totally incapacitated. If the man says that he is unfit for any work, the employer has no redress beyond taking the case into the County Court, a most unsatisfactory procedure.

The present definition of the disease in the schedule to the Act is a very broad one, and opens the way for the inclu-

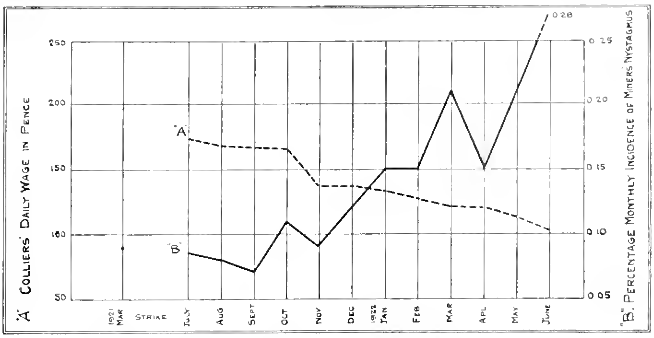

FIG. 2.—Showing rise in incidence of miners' nystagmus coincident with fall in wages.

sion of cases which are not those of miners' nystagmus. The certifying surgeon should not make the diagnosis of miners' nystagmus on the history given by the patient unless there is confirmation by physical examination. Rotatory and rapid oscillation of the eyes, true lid spasm associated with photophobia, head tremor (when combined with head resistance and backward inclination), and objective giddiness, may separately be considered sufficient to confirm diagnosis when accompanied by a typical history.

Irregular movements of the eyes, rolling about of the eyes, and blinking may all be purposive. Above all it is important to realize that a miner may develop a psychoneurosis quite apart from his underground life and, although he will probably refer his symptoms to his oculomotor apparatus, it by no means follows that the pit work is the cause of his incapacity. In all these cases the certifying surgeon must satisfy himself that objective signs are present, and he should not grant a certificate on a man's history alone. If he does, he will confirm the man in his neurosis and do him an unintentional injury.

Measures for the Prevention and Limitation of Incapacity

Preliminary Eyesight Test.—In addition to the various recommendations for the improvement of underground illumination made in the Report, some other suggestions for the prevention of the disease and the limitation of incapacity have been made. The writer (6) in 1920, when suggesting that a preliminary eye test should be carried out before engagement of the workman, proposed that a simple method would be for the official employing the man to make a rough estimate of his eyesight with the ordinary test letters, and to refuse him employment without a medical examination, if he has less than 6/12 vision.

This method has been carried out in the North Staffordshire coal field since 1913, but without any real measure of success. It was strongly advocated by Anderson in 1920 (8). Anderson maintains that only men with refractive errors develop nystagmus of sufficient severity to cause incapacity, and that every effort should be made to prevent them from obtaining employment underground. Here again the services of the school medical officer might be utilized, and a certificate of freedom from refractive error, obtained upon leaving school, should be in possession of youths seeking underground employment. The etiological importance of error of refraction is under debate, but the writer's opinion is that, even if it is not a factor in the actual production of the disease, it is a factor in the incapacity which results. For this reason steps taken to prevent the entry into the pits of lads and men with refractive error will eventually lessen the incidence of certified cases of nystagmus.

Necessity for Recertification.—The writer, in 1920, also suggested that the period of total incapacity should be limited, and that the men should be required to produce fresh certificates yearly, against which the employer should have the right of appeal under the machinery already existing. The Miners' Nystagmus Committee has adopted this principle of periodic right of appeal, and recommends that both workman and employer be granted power to appeal to the medical referee, at intervals of not less than six months from the date of the original certificate of disablement or the

date of last appeal, in order to assess the incapacity present. In this appeal the medical referee should certify that the man is either:

1. Totally incapacitated.
2. Partially incapacitated.
   a. Fit for surface work.
   b. Fit for suitable work below ground.
3. Not incapacitated.

Limitation of Incapacity.—The second principle advocated—that of limiting the period of total incapacity—is not without precedent, as glass workers' cataract entitles the workman to compensation for only six months. Generally speaking, all symptoms and signs of miners' nystagmus are lost after the man has left the pit for two years, often long before this time. Men only slightly afflicted can work on the surface without any delay. Cases in which the psychoneurotic element is marked run a very different course. The man may allege total incapacity years after he has left the pit, and long after all signs of the disease have disappeared. It might be thought that if the compensation of these men were cut down or stopped a hardship would be entailed; but these men, through the instability of their nervous systems, were from the first unfit for pit work and their breakdown was not entirely due to pit work. It is a well-known fact that 25 per cent. of all underground workers over 20 years of age show the physical signs of the disease but are free from symptoms. Some men develop the disease within a few months, while others work underground for years without any inconvenience. There must, then, be a personal factor which largely determines both the onset of the disease and the incapacity resulting from it.

The suggestion may now be made that compensation should automatically drop to two-thirds in the second year, and to one-third in the third year, at the end of which period it should cease, subject to an appeal to the medical referee, the onus of proof to rest on the workman.

TABLE 2.—RETURNS FROM MUTUAL INDEMNITY SOCIETIES FOR THE YEAR 1920

District	Percentage Incidence of Nystagmus	Cases Settled	Cost per Case in Year £	Percentage of Cases Working: Underground	Percentage of Cases Working: Surface
A	0.68	0	32	10.39	68.83
B	0.54	0	34	29.11	42.62
C	1.40	2	47	not available	
D	0.58	12	32	49.5	21.0
E	1.88	169	112	3.0	33.5
F	1.14	5	39	28 per cent. receive no compensation	
G	0.80	10	30	74 per cent. at work	
United Kingdom	0.72				

Lump Sum Settlements.—The alternative to the failure or rejection of the last two policies is that of lump sum settlement. The difficulty which the nystagmic workman has in finding surface employment at his own colliery has a very prejudicial effect on his recovery. Employment above ground, after a short preliminary rest in severe cases, is the only specific cure for nystagmus.

One of the great advantages of lump sum settlement is that it leaves the workman free to find in the open market work which, although not so remunerative as his old employment, helps in his recovery. Both workman and employer have to cut their losses and the former, if paid off, does not allow himself to drift into

the ranks of the "chronics" and unemployables. Table 2, taken from the Report, throws some doubt, however, on the wisdom of general lump sum settlements.

The high incidence of the disease, the low rate of return to work, and the high cost of the individual cases in district E appear to be directly related to the policy of settlement. In this district the men and their leaders are keenly alive to the advantages of lump sum payments. It is quite common, however, for the men to return to work underground after a lump sum settlement has been made. The geological conditions, methods of work, and life history of the cases show little difference from similar conditions in neighboring coal fields.

It is policy, for example, to settle as soon as possible a case of broken leg, if the injury is such that return to pit work is unlikely. One broken leg case does not lead to another; one nystagmus case may lead to two or three. The temptation of a man, who knows that he has nystagmus, to ask for a lump sum when he hears that his neighbor has just been paid off for the same complaint, is very great,—too great, in fact, for many workmen in times of stress. It follows, then, that although in the individual case the policy of settlement is sound, in the aggregate its wisdom is very doubtful. It might be policy for the employer to settle only long-standing cases, of two or more years' duration, for a sum equal, for instance, to three years' compensation. The workman should remember that these long-standing cases are due to a neurosis for which the underground work is not primarily responsible.

Conclusion

It would be ungenerous to conclude this paper without paying tribute to the majority of the underground workmen. No one who has had any experience with the disease can fail to be struck with the dogged courage shown by the afflicted. Many men hold on to breaking strain, and force their wills to overcome the many handicaps of the disease.

One may picture the suffering workman waiting behind at the pit bottom to allow the lamps of his fellow workmen to get out of sight, slowly developing his adaptation to darkness, and groping his way to the coal face where he is for a time more at ease. The constant stooping and bending soon set up oscillation of his eyes and the place swims before him. He cannot find any tool which he may happen to drop; he stumbles over loose lumps of coal; he knocks his head against the roof but still struggles on more by the sense of touch than by the sense of sight. At the end of the shift he waits behind in order to avoid the rush of the younger men, and finally reaching the surface has the same difficulty in his adaptation to light that he had on descent. In the old days the miner afflicted with nystagmus was often met at the pit top by his wife or child, and taken home. The giddiness which he develops keeps him at home through fear of being mistaken for a drunken man; the photophobia sends him to bed when the lamps are lighted; while headaches and disturbing dreams spoil his night's rest. These are the conditions under which many men show an endurance, not for one glorious moment, but for months, and their simple statement "I went as long as I could" chronicles a struggle of which any man might be proud.

Summary

1. The incidence of certified cases of miners' nystagmus has greatly increased since the introduction of compensation,

while unemployment and low wages have a similar effect.

2. The incapacity caused by the disease is largely due to the development of psychoneurotic symptoms.

3. The economic loss caused by the disease in Great Britain is at least £1,000,000 a year.

4. The following measures for the prevention and limitation of incapacity are recommended:

a. A preliminary eye test before engagement.

b. Provision of surface work.

c. Right of periodic appeal to a medical referee.

d. The automatic and gradual limitation of the amount of compensation paid.

e. A restricted policy of lump sum settlements.

f. The expansion of the school medical services for vocational selection of boys suitable for work underground.

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OBSERVATIONS UPON THE EFFECTS OF EXPOSURE TO ARSENIC TRICHLORIDE UPON HEALTH*

The Late Sheridan Delépine, M.B., C.M., M.Sc.

Prefatory Note

A WORKMAN employed during the war period in England upon the commercial production of arsenic trichloride died following the accidental spilling of some of this fluid over his right leg. This fatality led to an inquiry into the true cause of death, and to an examination of the conditions under which arsenic trichloride is manufactured and of the dangers to which the workmen are exposed. Laboratory research was undertaken to investigate (*a*) the local caustic action of arsenic trichloride, (*b*) the absorption of the poison through the skin, (*c*) the results of inhaling its vapor, and (*d*) the way in which risk to the workmen might be avoided. The paper which follows embodies the results of these different inquiries and investigations.

Investigation into a Fatality Following Spilling of Arsenic Trichloride upon the Leg

The deceased, a man aged 47, was employed in the manufacture of arsenic trichloride at a chemical works. The appearance of the leg is indicated in Figure 1. Examination of the organs and products of the body gave the results embodied in Table 1.

In order to stop putrefaction the organs, with the exception of the stomach, were immersed in a small amount of formaldehyde solution (carefully tested and free from arsenic). No formaldehyde was added to the blood. After a few days a fairly large amount of arsenic was found to have been taken up by the formaldehyde solution, and as time went on the amount of arsenic which could be recovered from the organs was found to have materially diminished. The same phenomenon was observed in samples of urine containing arsenic to which formal had been added.

The large amount of arsenic found in all the organs examined indicated that some soluble compound of arsenic had been freely distributed through the body, in all probability by the blood and lymph. The considerable amount of arsenic present in the liver can be explained by the well-known tendency which the poison has to be stored up in this organ. The large amount of arsenic found in the lung cannot be explained in the same way, and strongly suggests that shortly before death the patient had inhaled air laden with arsenic in some form. How much arsenic was absorbed through the skin of the leg cannot be inferred from the results of the postmortem examination.

The microscopic examination of the organs showed that the heart, liver, kidney, pancreas, and the gastric and duodenal glands were in a state of acute granulo-fatty degeneration; in addition to this, the liver and kidney showed slight chronic interstitial changes. The parenchymatous lesions were undoubtedly the result of acute arsenicism; the

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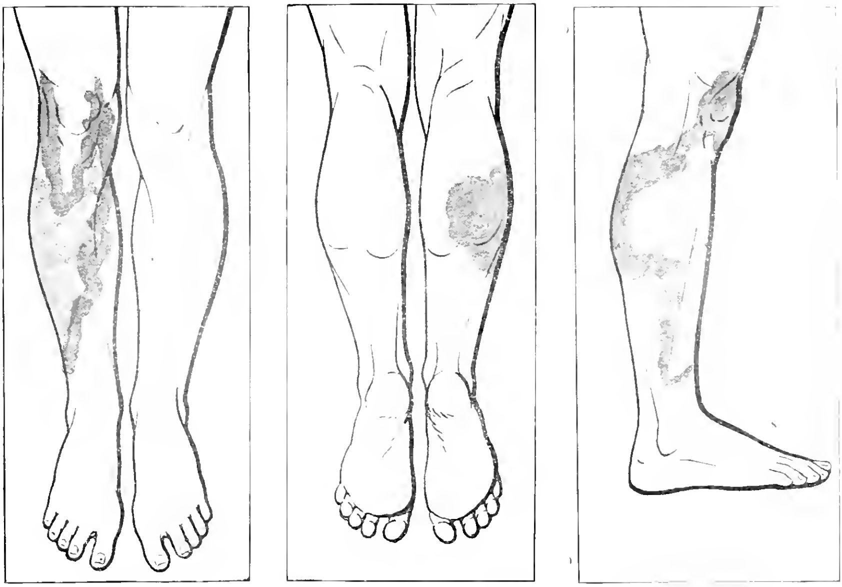

FIG. 1.—Appearance of leg after arsenic trichloride had been spilled upon it.

chronic interstitial lesions may or may not have been caused by chronic poisoning of the same kind. The state of the lungs also suggested the sudden action of some very irritating gas.

Owing to the fact that the patient suffered from suppression of urine almost from the first hours of his illness, death may be attributed to failure of the kidney, but the state of the lungs was sufficient to cause death, and the lesions of the liver, pancreas, and heart would also have been fatal more or less rapidly. The actual cause of the death was, therefore, *acute arsenicism*.

These findings indicated that men engaged in the same work as that on which the deceased was employed were probably exposed to very material danger, even in the absence of such an accident as that which brought about the fatal issue. The changes and the amounts of arsenic found in the various organs indicated that in all probability the cutaneous lesion was not the only channel through which arsenic had penetrated; and that the man had breathed air heavily laden with poison.

Under the supervision of Dr. A. E. McKenzie specimens of hair and also samples of urine were obtained from two men who had been engaged on the same work for six months. Both samples contained a material amount of arsenic. In addition to this, the presence of a large amount of purin bodies and of indican suggested the existence of degenerative changes in the tissues. The amount of arsenic found in the hair was considerable. The bulk of it was in the substance of the hair, for, after boiling it for one hour with 13 per cent. hydrochloric acid and extracting a first quantity of arsenic, a still larger quanti-

ty was obtained by boiling the hair again for two hours in 13 per cent. hydrochloric acid. The results of the examination of these samples are shown in Tables 2 and 3.

TABLE 1.—APPROXIMATE ESTIMATE OF THE AMOUNT OF ARSENIC PRESENT IN ORGANS AND PRODUCTS AVAILABLE FOR EXAMINATION

Organ or Material[1]	Average Weight of Organs	Actual Weight of Organs of Deceased	Value of Sublimate Obtained by Reinsch-Delépine Method per Gram of Original Material	Calculated Amount of Arsenic Trioxide in Material Examined	
				Moderate Estimate[1]	Maximum Estimate[2]
	gm.	*gm.*	*mg.*	*gm.*	*gm.*
Liver, after immersion in formaldehyde for 10 days (S.D.)	1,579	1,475	0.09	0.13275	— —
(f) Liver, after immersion in formaldehyde for 1 day (H.H.)	1,579	1,475	(0.2)	— —	0.295
Left lung (S.D.)	618	830	0.02	0.0166	— —
(f) Left lung (H.H.)	618	830	(0.10)	— —	0.083
Right lung	682	— —	— —	0.01364	— —
Left kidney	— —	159	— —	(0.00318)	— —
	277	319			
(f) Right kidney	— —	160	0.02	0.00320	— —
Pancreas	102	102	0.025	0.00255	— —
(f) Stomach	200	— —	0.0025	(0.0005)	— —
(f) Heart	400	380	0.005	0.0019	— —
(f) Blood of heart	approximate amount of blood about 4,000	:	0.0033	0.0132	— —
(f) Blood of heart, lung, and kidney		?	0.0033	0.0132	— —
Omental fat	— —	— —	0.015	— —	— —
Bile	— —	— —	present	— —	— —
Urine	— —	— —	present	— —	— —
First formal extract (liver, 500; lung, 400; pancreas, 60; kidney, 40; reduced to 350 c.c.)	— —	350	0.06	0.021	— —
Second formal extract of the same (not reduced)	— —	650	0.0016	0.00104	
				0.20956[3]	

[1] All the organs had been kept for several days in 4 per cent. formaldehyde solution except those marked (f), which had been kept only a few hours in the solution.

[2] In organs nearly fresh.

[3] According to the maximum estimates 0.22865 should be added, making a total of 0.43821.

Methods of Analysis

The method devised nearly three hundred years ago by the Dutch chemist, Glauber, is still in use for the preparation of arsenious chloride, or trichloride of arsenic ($AsCl_3$). It consists in distilling a mixture of arsenic trioxide with sulphuric acid and sodium chloride. The commercial product used was prepared according to this method. It is an oily, very mobile fluid, having a slight brownish color (pure arsenic trichloride is colorless), and, when exposed to ordinary air, it emits fumes and evaporates fairly rapidly. It is very poisonous and has well-known caustic properties (caustic oil of arsenic). When it is mixed with less than the quantity of water necessary to decompose it completely, an oxychloride of arsenic (AsO, Cl, H_2O) is produced. When a larger amount of water is employed, the final

products are hydrochloric acid and arsenic trioxide, the greater part of the latter being precipitated.

Ammonia gas is absorbed by arsenic trichloride with the production of a white solid, for which various formulae have been given by some of the earlier workers (H. Rose, Pasteur, and Michaelis). For the present purpose, $2\ AsCl_3, 7\ NH_3$ (Rose) will be sufficient simply to indicate in a broad way the nature of some of the changes which may be expected to take place in mixtures of air and arsenic trichloride vapors. The phenomena observed suggest the existence of many intermediary products which must be of considerable theoretical and practical interest to chemists.

TABLE 2.—APPROXIMATE AMOUNT OF ARSENIC IN HAIR AND URINE OF TWO WORKMEN AT SAME PLANT AT WHICH DECEASED WAS EMPLOYED

Name	Material	Amount Available for Analysis[1]	Value of Sublimates Obtained by the Reinsch-Delépine Method from 1 Gm. of Material	Calculated Amount of Arsenic Trioxide Passed in Urine in 24 Hours
		gm.	*mg.*	*gm.*
H. H.[2]	Hair	0.297	2.64	....
P. W. G.[2]	Hair	0.235	3.78	....
		c.c.		
H. H.	Urine	750	0.00196	0.001470
P. W. G.	Urine	360	0.00223	0.000802

1 Only a small amount of hair was available, because the men kept their hair very short. The urine is the whole amount for twenty-four hours.

2 H. H., aged 45; P. W. G., aged 35. Both men had been regularly employed at the plant for six months.

In all the experiments performed for the purpose of ascertaining the effects of arsenic trichloride upon the health of workers and other persons, crude arsenic trichloride from a factory was used. In the experiments devised for the study of the mode of diffusion in the air, in addition to the crude product, some pure arsenic trichloride was used for purposes of comparison. The close resemblance between the results obtained with the pure and with the commercial products showed that the effects observed were chiefly, if not entirely, due to arsenic trichloride.

TABLE 3.—GENERAL CHARACTERISTICS OF THE URINE OF TWO WORKMEN EXAMINED

	H. H.	*P. W. G.*
Color	Dark reddish yellow; on standing became dark sherry color	Reddish yellow, not so dark as that of H. H.; on standing became darker
Sediment	On standing, amorphous pale urates deposited first, then uric acid and large octahedral crystals of oxalate of lime. Yeasts were numerous	Same as in case of H. H., but on standing neither uric acid nor oxalate of lime separated. Yeasts were abundant
Specific gravity	1030	1027
Acidity	Considerable, increased on standing for several days	Same as in case of H. H.
Albumin	No appreciable amount	No appreciable amount
Glucose	" " "	" " "
Bile pigment	" " "	" " "
Indican	Very abundant	Present, but less abundant than in case of H. H.

Hydrochloric-Copper Method.—In the early parts of this investigation the only method used was one described briefly in the *British Medical Journal,* Jan. 12, 1901[1], and more fully in evidence given before the Royal Commission on

1 Delépine, S.: The Detection of Arsenic in Beer and Brewing Material. Brit. Med. Jour., 1901, *1,* 81.

Arsenical Poisoning. This method is suitable for the direct analysis of animal and vegetable products containing arsenious compounds, and it makes possible the detection of 0.01 mg. of arsenic trioxide in 100 gm. of fluid (corresponding to a dilution of 1 in 10,000,000). In this method trichloride of arsenic is first produced, then arsenide of copper, which is then converted to arsenic trioxide and collected in the form of a crystalline sublimate in suitable sublimation tubes. For short, this method is referred to as the hydrochloric-copper method

When the amount of arsenic in 100 gm. of the material corresponds to more than 0.01 and less than 0.1 mg. of arsenic trioxide, it is possible to estimate with approximate accuracy the amount of arsenic present in the material, by comparing the sublimates obtained with standard sublimates. In order to obtain more accurate estimates, it is necessary to bring the amount of arsenic in the amount of material tested to between 0.02 and 0.05 mg. This can easily be done by concentration or dilution of the original material.

Fluids, such as urine or solutions obtained by washing air or various articles in suitable solvents, can be dealt with directly. To 100 c.c. of these fluids, 20 c.c. of arsenic-free hydrochloric acid and two equal pieces of arsenic-free copper foil having an aggregate surface of 144 sq. mm. are added. This mixture is kept boiling uninterruptedly for two hours. The two pieces of copper are then thoroughly washed and dried, and one of the pieces is carefully heated in a sublimation tube of standard size.

Solids, such as hair, liver, kidney and other organs, previous to being treated as described in the foregoing, are disintegrated by being boiled for about two hours with as much arsenic-free hydrochloric acid and water as is necessary to bring the proportion of strong hydrochloric acid to one-third of the total mixture. To prevent loss of arsenic trichloride, all these operations are conducted in flasks provided with reflux condensers.

We were convinced that, after exposure to arsenic trichloride fumes for a comparatively short time, hair and other products became laden with a large amount of arsenic, and that ordinary volumetric methods, such as the iodine method, would, therefore, be sufficiently delicate for practical purposes. This view was confirmed by the results obtained by Mr. Heap, who was entrusted with the volumetric estimations of the arsenious compounds collected in the various fluids or on the surface of the test plates used in connection with experiments upon the distribution of arsenic trichloride in the air. This method of estimation was conducted by Mr. Heap as follows:

Iodine Volumetric Method.—When the arsenious compound is in solution in water the titration is made by rendering the solution quite alkaline with sodium bicarbonate, adding an excess of centinormal iodine solution, and titrating back the excess with standardized sodium thiosulphate. In cases where potassium hydrate has been used either as absorbent or as solvent for the arsenious compound, the potash is neutralized by the addition of an excess of hydrochloric acid; then the excess of acid is neutralized by careful addition of sodium bicarbonate, and afterwards an excess of sodium bicarbonate is added. This solution is titrated as stated above. From the amount of iodine required for oxidation, the quantity of arsenic present as arsenious acid is calculated.

It is possible by this method to estimate quantities of arsenious compounds

exceeding 0.025 mg. (0.000025 gm.). Results indicating quantities below 50 mmg. cannot be expected to have a high degree of accuracy.

Estimates of the amount of arsenic in some samples of hair were made by both the iodine method and the hydrochloric-copper method for purposes of comparison, and the results were found to be in general agreement. (The figures given in the sections relating to hair and urine have all been obtained by the hydrochloric-copper method; those relating to arsenic collected from the air, in fluid solvents, or on test plates have been generally obtained by the iodine method).

Unit Used for Recording Purposes.—For the purpose of making it possible to compare easily the proportional amount of arsenic in various animal or other products, it is convenient to take the millimilligram as a unit (0.000001 gm.) and to calculate the amount of arsenic (as arsenic trioxide) present in standard quantities of 100 gm. of solids or 100 c.c. of liquids. With regard to gases, 1,000,000 c.c. might be adopted as a standard quantity approximating roughly the solid and liquid standards (1,112,000 c.c. of hydrogen weigh 100 gm. at 0° C. and 760 mm. pressure. A cube with a 100 cm. side contains 1,000,000 c. c.).

The millimilligram unit is below the limit capable of direct estimation. The smallest amount which can be determined by direct observation when the hydrochloric-copper method is used is 1 cmg.; the adoption of the millimilligram unit is, however, convenient to avoid fractions in calculated results. The iodine method is less delicate and is open to various objections, but as an estimate can be made by a single analysis, it saves a considerable amount of time.

Amount of Arsenic in Hair and Urine of Persons and Animals Exposed to Arsenic Trichloride Fumes, and of Other Persons and Animals

In summing up the results of this part of the investigation it will be convenient to divide them among the following groups:

A. Men engaged in the manufacture of arsenic trichloride.

B. Chemists frequently sampling and testing arsenic trichloride.

C. Patients treated with organic arsenical preparations taken internally.

D. Persons working in a laboratory where experiments involving the occasional handling of arsenic trichloride are conducted.

E. Animals not exposed to arsenic trichloride fumes.

F. Laboratory worker, experimenting with arsenic trichloride under favorable conditions, before and after short exposures to the fumes.

G. Animals exposed experimentally to arsenic trichloride fumes.

The main results are summed up in Table 4; other cases and fuller details will be found in later sections.

Effects of Experimental Exposures to Arsenic Trichloride Fumes

The animals used in these experiments were rabbits, guinea-pigs, rats, and mice. The experiments were attended with some difficulty on account of the mobility of the fluid and of the diffusibility of the vapors; this was a source of trouble not only on account of the care which had to be exercised in order to limit the action of the poison, but also on account of the unpleasant effects which the experimenter experienced at times.

The experiments may be divided into

TABLE 4.—AMOUNT OF ARSENIC FOUND IN HAIR AND URINE OF PERSONS AND ANIMALS EXPOSED TO ARSENIC TRICHLORIDE FUMES AND OF SOME OTHER PERSONS AND ANIMALS

Group	Subject	Date	Arsenic per 100 Gm. of Hair *Mmg.*	Arsenic per 100 C.C. of Urine *Mmg.*	Remarks
Amount of Arsenic in Hair and Urine of Persons in Groups A, B, C, and D					
A. Persons engaged in manufacture of arsenic trichloride	H.	Sept.	264,000	220	After a short period of rest following material exposure.
		Oct.	500,000	80	After one month's work under improved conditions.
		Dec.	6,000	under 10	After two months' suspension of work.
	G.	Sept.	378,000	250	After short suspension of work after material exposure.
		Oct.	600,000	80	After one month's work under improved conditions.
		Dec.	25,000	under 10	After two months suspension of work.
	A.	Nov.	22,500	" "	After suspension of work for several weeks.
	B.	"	75,000	" "	After suspension of work for several weeks.
B. Chemists engaged in sampling and testing arsenic trichloride	K.	Oct.	80,000	55? 10	Preventive precautions not long in force.
		Nov.	60,000	under 10	One month later.
	J.	Oct.	75,000	40 40	" " "
		Nov.	45,000	under 10	" " "
	H.	Jan.	280,000	—	Chemist engaged in work at B. R. plant (arsenic trichloride).
C. Patients taking arsenic internally, not exposed to arsenic trichloride	9523	Dec.	8,000	36,000	Ends of long hair only examined (female).
	9524	"	7,000	8,000	Ends of long hair only examined (female).
D. Persons working in a laboratory where occasional analyses of arsenical products are conducted. Seldom exposed to arsenic trichloride and then to a very slight extent. All dwellers in a large industrial town	H. H.	Oct.	4,000	—	Chemical work chiefly.
	S. D.	"	3,000	under 5	Experimental biological work chiefly.
	E. I.	"	1,000	" "	Clerical work chiefly; end of long hair, covered by other hair (F).
	F. S.	"	3,000	—	General laboratory worker.
	F. D.	"	3,000	—	Laboratory work, including the use of arsenical solutions.
	R. C.	"	2,500	—	General work and glass blowing.
	R. F.	"	1,000	—	General laboratory work.

two main groups: (1) inunction experiments—namely, those in which arsenic trichloride was applied to the skin (the respiratory organs being protected); and (2) inhalation experiments.

In all these experiments crude arsenic trichloride was used. Its properties corresponded in all important particulars with those of pure arsenic trichloride prepared at the laboratory.

Direct Application of Arsenic Trichloride to the Skin

The object of these experiments was to ascertain not only the nature of the

TABLE 4.—*Continued*

Group	Subject	Date	Arsenic per 100 Gm. of Hair *Mmg.*	Arsenic per 100 C.C. of Urine *Mmg.*	Remarks
			Amount of Arsenic in Hair of Animals Kept in Town		
E. Animals in animal house. Not exposed to arsenic trichloride	rabbit	Oct. 16	1,500	—	Coke fire beginning. Dorsal hair chiefly.
	6 guinea-pigs	Dec. 21	4,000	—	Coke fire for two months. Dorsal hair.
			Amount of Arsenic Found in Hair of One Person and Several Animals Exposed Experimentally to Arsenic Trichloride Fumes		
F. Laboratory worker before and after exposure to arsenic trichloride	S. D.	Oct. 16	3,000	—	Before beginning experiments with arsenic trichloride.
	" "	Dec. 16	6,000	—	After carrying out occasional experiments with arsenic trichloride in the course of six weeks.
	" "	Dec. 21	19,000	—	Three hours after visiting an arsenic trichloride plant.
	" "	Jan. 28	40,000	—	Eight days after making experiments with the 215,000 c.c. chamber.
G. Animals exposed experimentally to arsenic trichloride fumes	guinea-pig	Dec. 8	dorsal, 35,000 ventral, 27,500	— —	Forty-five minutes' exposure to fumes scarcely visible near inlet of chamber.
		" " Dec. 16	dorsal, 40,000 ventral, 12,000	— —	Companion to guinea-pig in above experiment.
	" "	Dec. 11	— —		One hundred and fifty minutes' exposure to invisible fumes of arsenic trichloride.
	" "	Dec. 21	dorsal, 21,000	—	Dorsal hair of two guinea-pigs clipped ten days after exposure.
	" "	Dec. 11	dorsal, 95,000	—	Forty minutes' exposure to dense visible fumes of arsenic trichloride.
	" "	" "	dorsal, 70,000	—	Companion to guinea-pig in above experiment.
	" "	Jan. 18	dorsal, 100,000	—	Eighty-eight hours after exposure to dense arsenic trichloride fumes.
	" "	" "	dorsal, 160,000	—	Eighteen hours after exposure to air loaded with arsenic trichloride.

local lesions, but also to what extent absorption took place through the skin, and thus exposed the animal to general poisoning.

Immediately after arsenic trichloride is applied to the skin, a bulky light cloud arises from the treated part and continues to be visible in a gradually diminishing degree for about twenty to thirty minutes. In order to prevent the vapors from reaching the respiratory passages, it was necessary to drive the fumes away from the mouth and nose by causing a current of air to pass over the animal from head to tail. For this purpose a strong current of air was produced by an

electric fan, and the fumes were driven out of the room through an open window immediately behind the animal.

Except in one experiment, in which a small fraction of the fluid crept up accidentally along the skin, only the distal half of the tail of each rat was treated. This arrangement permitted the tail to be thoroughly washed by dipping and agitating it in a large amount of water at definite intervals in order to remove that portion of the caustic which had not already penetrated into the tissues. Arsenic trichloride was applied to the skin by means of a 0.25 c.c. or of a 0.10 c.c. glass pipette. The fluid appeared to dry rapidly, the hair and skin becoming rapidly covered by a white efflorescence. After being kept under observation for some time, the animals were transferred to cages in which their excreta could be collected. After the death of each animal a postmortem examination was made, and various tissues or organs were taken for microscopic and chemical examination.

Owing to the smallness of the organs in the rat, it was difficult to estimate with much accuracy to what extent arsenic passed into the subcutaneous tissue and how it was distributed in the various organs. It was, therefore, necessary to use a rabbit. The animal was placed with its tail toward an open window, and during the experiment air was driven from head to tail so as to cause the animal to breathe only fresh air. Then 0.12 c.c. of arsenic trichloride was applied to the back of the inner border of each ear, so as to cover only the distal two-thirds of the organ over a width of 1 to 2 cm. After an interval of one minute one of the ears was washed with an abundant stream of water, after which it was dried with filter paper. The other ear was washed five minutes after treatment.

The application of arsenic trichloride was at once followed by evidence of sharp pain which subsided almost immediately, the part treated becoming rapidly insensitive, but the skin in the immediate neighborhood was painful when touched. The application of water was apparently painful at first, but the pain disappeared rapidly. The roots of both ears remained painful to the touch until the animal died.

The same efflorescence which had been noticed in the experiment on the rat was obvious. This was reduced by washing but reappeared when the ear again became dry. When the ears were apparently dry, the animal was removed to its cage, where it remained quiet and showed no sign of pain nor any desire to escape.

The following is a summary of the results of four experiments in which arsenic trichloride was applied to the skin of animals.

Experiment 1.—This consisted in the application of 0.25 gm. of arsenic trichloride to the greater part of the tail of a white rat. The tail dried rapidly and was afterwards covered with a white efflorescence. Death occurred an hour and a quarter after the application of the arsenic trichloride.

The amount of arsenic (as arsenic trioxide) found by postmortem examination was as follows:

	Mmg. per 100 Gm.
Liver	3,320[1]
Hair of back and sides (It is possible that some fluid had spread up the skin of the back.)	20,000
Middle part of tail	25,000

[1] Owing to an accident, this estimate is not reliable; the actual amount of arsenic in the liver was probably quite small. It seemed desirable, however, to record all the results obtained.

Experiment 2.—In this experiment 0.25 gm. of arsenic trichloride was applied to the distal half of the tail of a white rat. The fluid, however, spread along the skin toward the root of the organ. After a minute and a half, the distal half of the tail was washed in water; a minute and a half later the tail was washed again up to about 2 cm. from its root,

and was dried with filter paper. The rat was killed three days and eight hours after the application of the arsenic trichloride.

The amount of arsenic (as arsenic trioxide) found by postmortem examination was as follows:

	Mmg. per 100 Gm.
Brain	3,900
Liver	740
Muscles and bones of neck, thorax, and anterior lumbar region (limbs, head, posterior lumbar and sacral region not included)	468

Experiment 3.—In this experiment 0.1 gm. of arsenic trichloride was applied to the distal half of the tail of a white rat. Fumes were visible for thirty minutes. The hair rapidly became coated with a white efflorescence. Death occurred three days and five hours after exposure.

The amount of arsenic (as arsenic trioxide) found upon examination was as follows:

	Mmg. per 100 Gm.
Liver	600
Bones and muscles of sacrum and lumbar region	220
Urine collected between fourth and fifty-ninth hours	520
Feces passed during second and third days, and the contents of the colon postmortem	6,000[1]

[1]There may have been some arsenic introduced by external fumes and supporting board.

Experiment 4.—Arsenic trichloride was applied to the back of the inner border of each ear of a rabbit over the length of 6 cm. from the top, and over a width of about 1½ cm. (0.12 gm. was applied to each ear). One minute after the application, the left ear was thoroughly washed with 300 c.c. of water squirted over it, after which it was dried with filter paper. Five minutes after the application the right ear was washed in the same way.

The amount of arsenic (as arsenic trioxide) found upon examination was as follows:

	Mmg. per 100 Gm.
Brain	1,050
Nose, mucous membrane, hard palate, nasal bone, nasal part of upper maxilla (external nostrils removed)	5,500
Lungs	16,000[1]
Liver	4,000
Kidneys	1,080
Hair, dorsal	10,000
Subcutaneous tissue, root of left ear edematous connective tissue only	48,720
Side of head, temporo-pterygoid region, including some edematous muscular tissue, but no skin or bone	9,120

[1]This figure is doubtful.

Inhalation Experiments

In these experiments two types of experimental chambers were used, one of which was of large size and permitted the study of the effects of vapors of arsenic trichloride when they were in the presence of an excess of air. To study the effects of short exposures to air uniformly charged with arsenic trichloride vapors, much smaller chambers were used which made it possible to replace the normal air rapidly by a current of air containing a known quantity of arsenic trichloride.

Inhalation of Fumes of Arsenic Trichloride in Presence of an Excess of Air.—The experimental chamber used in these experiments had a capacity of about 215,000 c.c. (allowing for the space occupied by animals, cages, etc.). This chamber could accommodate several small animals at the same time (allowing 60 liters of air per pound per hour for the respiratory needs of small animals there was more than enough air in the chamber for four guinea-pigs of moderate size, even when the air was not renewed for one to two hours).

This chamber was also used for studying the distribution of arsenic trichloride fumes by various methods, including the test plate method, which is described in later sections of this report. (The same apparatus was used in experiments on the effects of sewer air upon health. See Report to the Sewer Ventilation Committee of the Manchester Corporation, 1909.) The chamber measured 102 cm. in length, 46 cm.

in height, and 46 cm. in width. It was closed above by means of a thick glass plate, the joint between the glass plate and the flange surrounding the opening of the chamber being made air-tight by means of a bed of vaseline clay. In later experiments adhesive plaster was found more convenient. At each end of the tank there was a tubular opening through which tubes of various sizes up to 1 inch in diameter could be fixed. These tubes served as inlet and outlet tubes, respectively, and by means of suitable elbows the levels and position of the inlet and outlet tubes could be adjusted.

In the first two experiments the animal cages were supported by a perforated floor at a height of 6 cm. above the opening admitting the gas. In the subsequent experiments the perforated floor was removed, and the cages were laid on the floor, two cages near the inlet and two cages near the outlet. These cages were made of wire net and allowed free circulation of gases during the experiments.

To introduce arsenic trichloride fumes into this chamber, air was sometimes caused to bubble through a very thin layer of arsenic trichloride placed in a suitable, comparatively large gas washing bottle. At other times the air was made to pass over the surface of the arsenic trichloride contained in a small light conical flask. The distance between the ends of the inlet and outlet tubes in the small flask was about 2 cm. The surface of arsenic trichloride exposed at the bottom of the flask did not exceed 7 cm. square. This arrangement was particularly useful because the flask was light, and could be closed and weighed accurately immediately before and after each experiment. It was thus possible to estimate to 1 cg. the amount of arsenic trichloride which had been vaporized and had mixed with the measured amount of air that had passed over it.

In several experiments made respectively with air dried over sulphuric acid or with air almost saturated with water, it was found that at a temperature of 15° to 17°C., when the flask contained 2.34 gm. of arsenic trichloride, about 0.09 to 0.13 gm. of the arsenic trichloride was abstracted in five minutes by the passage of 3,300 c.c. of air over the surface of the fluid. (When the air was caused to flow over the fluid by reduction of pressure in the large chamber, great irregularities were observed, probably owing to the difficulty of avoiding leakages. The most concordant results were obtained by blowing air under slight pressure over the surface of the liquid arsenic trichloride.)

When moist air is passed continuously over arsenic trichloride, a thin layer of watery-looking fluid containing hydrochloric acid forms over the surface of the brownish fluid which becomes distinctly turbid. The rate of vaporization is then diminished. The same change occurs when arsenic trichloride remains exposed to damp air for some time. When the object of the experiments was to estimate the effects of air containing definite proportions of arsenic trichloride, it was necessary to use fresh fluid for each experiment, and to reduce the duration of the exposure to a few minutes. The details of the experiments performed in the large (215,000 c.c.) chamber follow.

Experiment 5.—A stream of damp air charged with arsenic trichloride was admitted to the large chamber by an inlet near the bottom of the chamber, which was covered with a thin layer of water. A guinea-pig was placed 6 cm. above the level of the inlet and 30 cm. from it. Fifty-four thousand centimeters of air passed over 1 c.c. of arsenic trichloride in fifty-five minutes. Thin

curly clouds of fumes rose to the upper part of the chamber in the neighborhood of the inlet. The air of this chamber was not generally cloudy. Death occurred four hours and twenty-five minutes after exposure.

The amount of arsenic (as arsenic trioxide) found in the hair of the guinea-pig was as follows:

	Mmg. per 100 Gm.
Hair, dorsal	35,000
Hair, ventral	27,500

The total amount of arsenic recovered at the end of the experiment was:[1]

	Mmg.
Contents of wash bottle at outlet	about 640
Calculated average contents of 215 liter chamber at end of experiment	about 2,750

(Most of the arsenic trichloride must have decomposed in the chamber and yielded deposits in the third of the chamber near the inlet.)

[1]These estimates are of doubtful value.

Experiment 6. — A guinea-pig was exposed at the same time as the guinea-pig in Experiment 5 but not quite so near the inlet and not so clearly on the path taken by the fumes (for details see Experiment 5). Death occurred ten days after exposure.

The amount of arsenic (as arsenic trioxide) found in the hair of the guinea-pig was as follows:

	Mmg. per 100 Gm.
Hair, dorsal, twenty-four hours after exposure	40,000
Hair, dorsal, eight days after exposure	12,000

The total amount of arsenic recovered at the end of the experiment was:[1]

	Mmg.
Contents of wash bottle at outlet	640[2]
Calculated contents of 215 liters of air at end of experiment (see Experiment 5)	2,750[2]

[1]See remarks under Experiment 5.
[2]Probably underestimated, only one absorption tube being used.

Experiment 7. — A stream of air charged with arsenic trichloride was admitted to the 215,000 c.c. chamber as in Experiments 5 and 6, but in this case the bottom of the chamber was dry. A guinea-pig was placed 6 cm. above and 30 cm. from the inlet. Thirty thousand cubic centimeters of air were allowed to pass over 1 c.c. of arsenic trichloride in 120 minutes (somewhat intermittently). Small clouds issued at intervals from the inlet. The animal was left eighty minutes longer in the chamber. The clouds rose at once to the top of the chamber, rolling slowly toward the outlet but dispersing before they reached the middle of the distance between the inlet and the outlet. At no time was the chamber entirely filled with fumes.

The guinea-pig was killed forty-six days after exposure. By analysis the following amounts of arsenic (as arsenic trioxide) were found:

	Mmg. per 100 Gm.
Liver	doubtful trace
Hair (A) equally mixed dorsal hair of guinea-pigs of Experiments 7 and 8, clipped ten days after exposure	21,000
Hair (B) of same guinea-pigs clipped forty-five days after exposure	4,000

The total amount of arsenic recovered was as follows:[1]

	Mmg.
White deposit formed on plate in chamber on a surface 78.5 cm. square	over 80,000
Calculated deposit on total area of floor of chamber and animals (area of floor 4,692 sq. cm.)	597,000
Contents of two absorption tubes and water at outlet of chamber	891
Calculated contents of air in chamber at end of experiment	6,237

[1]See remarks under Experiment 5.

Experiment 8.—The guinea-pig used in this experiment was exposed along with the guinea-pig in Experiment 7. The details of the experiments are the same. The animal died ninety-seven days after exposure. No analyses were made.

Experiment 9. — A stream of air was charged with arsenic trichloride by being blown through a thin layer of the fluid before being admitted to the 215,000 c.c. chamber through an inlet at the upper part of the chamber. A guinea-pig was placed 30 cm. below the inlet and at a distance of about 70 cm. from it. Thirty liters of air passed over the arsenic trichloride in forty minutes. The guinea-pig was left in the chamber eighty

minutes after the end of the passage of air laden with the fumes. The inlet half of the chamber rapidly filled with dense fumes, which completely hid the bottom of the chamber. The guinea-pig died in less than eighteen hours after exposure.

By analysis the following amounts of arsenic (as arsenic trioxide) were found:

	Mmg. per 100 Gm.
Stomach and intestine....	227
Hair, dorsal.............	95,000
Muscles of bones and trunk, after removal of head and all viscera........	45

The total amount of arsenic recovered was:[1]

	Mmg.
Contents of two absorption tubes of water and of potassium hydroxide at outlet of chamber..............	3,514
Calculated arsenic content of air in chamber at end of experiment.....	24,598

[1]See note under Experiment 5.

Experiment 10.—This was a duplicate of Experiment 9. The only difference was in the weight of the animals. The guinea-pig died in less than eighteen hours.

The following amounts of arsenic (as arsenic trioxide) were found:

	Mmg. per 100 Gm.
Liver and one kidney......	1,494
Hair, dorsal.............	70,000

For the calculated arsenic content of the air in the chamber, see Experiment 9.

Experiment 11. — (See also Experiments 12, 13, and 14.) A stream of air was passed over arsenic trichloride and was then freed from suspended particles and excessive moisture by passage through 15 per cent. sulphuric acid before admission to the 215,000 c.c. chamber, by the upper inlet. Ten liters of air laden with arsenic trichloride passed through the chamber in thirty minutes. (During the first ten minutes about 3 liters of air were lost.) About 0.252 gm. of the arsenic trichloride evaporated. A rat was placed on the floor of the cage 37 cm. below the level of the *inlet* and 20 cm. on one side of it. In this part of the chamber fumes were not visible. They were most marked in the middle third of the chamber. In the outlet third they were visible but not so thick as in the middle. The rat lived for ten days and was then used for Experiment 15.

From the second to the fifth day of the experiment 38 c.c. of urine were collected, and of this amount 19 c.c. were used for chemical analysis. Only a doubtful trace of arsenic was found.

Experiment 12. — The arrangement was the same as that in Experiment 11, except that the rat was placed at a distance of 20 cm. on one side of the *outlet* and 37 cm. below its level. (The distribution of fumes was the same as in Experiment 11.) The rat died within four days after exposure.

The following amounts of arsenic (as arsenic trioxide) were found by analysis:

	Mmg. per 100 Gm.
Liver	less than 82
Urine (19 c.c. passed in three days before death)	105
Hair, dorsal, clipped post-mortem four days after exposure	72,000

Experiment 13. — The arrangement was the same as that in Experiment 11. The guinea-pig was placed at the same distance from the *inlet* as the animal in Experiment 11, but on the opposite side (see remarks under Experiment 11 about the distribution of fumes). This experiment was partly spoiled because the guinea-pig escaped and went to the outlet part of the chamber during the exposure. Death resulted in less than eighty-eight hours after exposure.

The following amounts of arsenic (as arsenic trioxide) were found:

	Mmg. per 100 Gm.
Nasal soft tissue and bones, including palate (olfactory lobes excluded)....	3,600
Brain and cerebellum......	4,800
Lungs	1,440
Liver, average of two estimates made............	1,405
Kidneys and adrenals.....	6,840
Hair, dorsal.............	100,000

Experiment 14. — The arrangement was the same as that in Experiment 11. The animal was placed at the same distance from the *outlet* as in Experiment 12, but on the opposite side of it. (The distribution of fumes was the same as in Experiment 11.) Death occurred in less than eighteen hours after exposure.

By analysis the following amounts of arsenic (as arsenic trioxide) were found:

	Mmg. per 100 Gm.
Nose and soft part with upper maxillary and palate bones (skin and superficial muscles and brain excluded)	6,720
Lungs	805
Liver	2,000
Hair, dorsal..............	160,000

Experiment 15. — (See also Experiment 16.) Arsenic trichloride fumes were allowed to diffuse in the still air of the 215,000 c.c. chamber. Arsenic trichloride (0.25 c.c.) in a shallow capsule was placed at a height of 23 cm. above the floor of the chamber. A rat was placed in a wire cage about 20 cm. below the capsule, and almost immediately under it. The chamber was closed hermetically (after the rat of Experiment 16 had also been placed in it). A test plate placed 20 cm. above the arsenic trichloride was covered with a thick white deposit at the end of the experiment. A test plate 20 cm. below the capsule was covered with a thinner deposit (see also Experiment 16). The duration of exposure was six hours and forty-five minutes. Death resulted in less than forty-five hours after exposure.

The amount of arsenic (as arsenic trioxide) found in the liver and hair of the rat was as follows:

	Mmg. per 100 Gm.
Liver	832
Hair, dorsal..............	20,000

The following amounts of arsenic were recovered from the deposits on the test plates:

	Mmg.
Plate 20 cm. above capsule..........	6,400
Plate 20 cm. below capsule..........	3,200
Plate 55 cm. above capsule..........	2,400
Plate 55 cm. below capsule..........	2,400

Experiment 16. — The arrangement was the same as that in Experiment 15, but the rat was placed at a distance of 50 cm. laterally from the arsenic trichloride capsule. Test plates were placed at the level of the animal and at a height of about 40 cm. above it in positions corresponding to those of the plates placed immediately above and below the capsule. The amount of deposit on these distant plates was much smaller than on the other plates (see Experiment 15).

The rat was quite well after ten days, and was not killed.

Inhalation of Air Uniformly Charged with Definite Amount of Arsenic Trichloride and not Allowed to Mix afterwards with Ordinary Air.—A small glass chamber (of 140 c.c. capacity), in which a mouse could easily be accommodated, was used for this series of experiments, the object of which was to determine the pathogenic effects of air containing a definite amount of arsenic trichloride. Two smaller chambers (of 55 c.c. capacity) were also used simultaneously, for the purpose of comparing the effects upon two mice of the same mixture of air and arsenic trichloride, one-half of which had been caused to pass through a wet sponge (Fig. 2).

The 140 c.c. chamber was originally designed for experiments upon the exhaust gases from internal combustion engines. The mouth of the chamber, through which the animal was introduced, was closed by a large glass stopper. An outlet tube, provided with a glass stopcock, was connected with the chamber close to its mouth, and at the opposite end of the chamber there was an inlet tube also provided with a stopcock. When ordinary air was made to pass freely through this chamber by connecting its outlet with an aspirator or its inlet with a blower, a mouse could live in it comfortably for many hours and without showing any sign of discomfort.

Owing to the small size of the chamber and to the position of the head of the mouse, which was quite close to the inlet opening, it was easy to submit the animal to exactly timed exposures to gaseous mixtures of definite composition, and to watch closely the effects.

In all the experiments two 10-liter aspirators were used either to force air into, or to abstract air from, the experimental chamber. The lower openings of these bottles were connected by a long

india-rubber tube, and the upper parts of the bottles were connected with another tube of the same length as the first. This second tube had in its length a T-tube, each branch of which was provided with a glass stopcock. The upper opening of each bottle was also provided with a second tube with a stopcock. This formed a closed system in which the same amount of water could be used over and over again either to aspirate or to blow air through the experimental chamber and to collect in one bottle exactly the amount of air driven out of the other bottle. The object of this was to prevent an escape of poisonous fumes into the room. The cloudy fumes collected over water in one of the bottles gradually disappeared, and the gas could then be expelled without serious inconvenience.

The smaller twin chambers, used for comparing the effects of the same mixture of gas both filtered through a wet sponge and unfiltered, were used in the same way. In order to regulate the flow of gas, however, so as to insure that the same amount passed through the two chambers, a bubbling flask was connected with the outlet of each experimental chamber and the amount of gas admitted to each chamber regulated by taps until the amount issuing from one of the chambers was equal to that escaping from the other.

Previous to admission to the experimental chamber, the air was charged with arsenic trichloride by being made to pass over the surface of arsenic trichloride in the small flask previously described. The weight of this flask and its contents was taken immediately before and after each exposure, so that the amount of arsenic trichloride taken up by a measured quantity of air could be accurately ascertained. The air was sometimes dried by being caused to bubble through strong sulphuric acid, and was sometimes saturated with moisture by being made to bubble through water. This was done either before or after the air had been charged with arsenic trichloride. The details of the experiments made in these small chambers (of 140 c.c. and 55 c.c. capacity) follow.

Experiment 17.—Dry air was passed over arsenic trichloride and afterwards through sulphuric acid. The mixture as admitted to the experimental chamber was quite dry. Three thousand and three hundred cubic centimeters of air containing 0.11 gm. of arsenic trichloride passed through the chamber in five minutes. This dry mixture remained clear until it reached the inlet of the chamber, and then it became cloudy in the neighborhood of the head of the mouse Forty-four minutes after exposure the mouse died.

Experiment 18.—Moist air was passed over arsenic trichloride and afterwards through a thin layer of water. Three thousand and three hundred cubic centimeters of moist air containing 0.13 gm. of arsenic trichloride passed through the chamber in five minutes (after being washed through a small amount of water). This damp mixture was quite cloudy after passing through the water, and the chamber was immediately filled with this cloudy mixture. The mouse used was quite well after twenty-one days.

Experiment 19.—In this experiment 3,300 c.c. of moist air, which had been passed over arsenic trichloride and which contained 0.09 gm. of arsenic trichloride, was admitted direct to the chamber. The air was uniformly cloudy after its passage through the arsenic trichloride, and the chamber was immediately filled with this cloudy mixture. The mouse used in this experiment died fifty-two minutes after exposure.

Experiment 20.—Two mice were exposed simultaneously for five minutes to the same quantity (3,400 c.c.) of air charged with 0.128 gm. of arsenic trichloride. In one case air from a flask of arsenic trichloride was passed through an intermediate chamber containing only a baffle to prevent suspended particles from being carried over to the 55 c.c. mouse chamber. The mouse died in fifteen minutes.

Experiment 21.—In the other the air from the flask of arsenic trichloride was passed

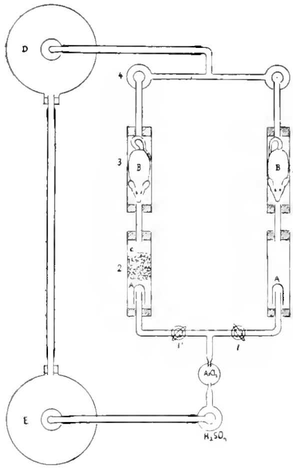

FIG. 2.—Twin glass chambers for comparative experiments on mice. (Scale 1 to 9.)

H_2SO_4=bubbling flask (containing strong sulphuric acid when dry air is desired, water when air saturated with moisture is desired, or nothing). $AsCl_3$=small flask containing arsenic trichloride. 1 and 1′=stopcocks on inlet tubes. 2 and 2′=intermediary chambers (2′ contains sponge C). 3 and 3′=mouse chambers. 4 and 4′=bubbling flasks used to estimate the rate of air current which is regulated by stopcocks 1 and 1′. A=part of intermediary chambers 2 and 2′ near baffle on inlet tube. B3=mouse exposed to untreated fumes; B3′=mouse exposed to air filtered through moist sponge C. C=moist sponge. D=aspirating flask. E=blowing flask.

through an intermediate chamber containing a baffle and, in addition, a wet sponge through which the gaseous mixture had to pass before being admitted to the 55 c.c. mouse chamber. With the exception of the sponge, this half of the apparatus was identical with that used for Experiment 20. The mouse was quite well at the end of twelve days.

Microscopical Lesions Observed after Inhalation of Arsenic Trichloride

With the object of ascertaining the effects produced by arsenic trichloride fumes upon the large air passages, sections through the anterior parts of the nasal passages, the supraglottic and infraglottic parts of the larynx, and the lower part of the trachea were made in several of the cases. The histological changes in the lungs, liver, and kidney were also studied in nearly every case. The necessity of keeping material for chemical examination, and the smallness of the parts did not permit of an histological examination in every case.

Owing to an unfortunate mistake made in the preparation of the hardening medium, the reactions and appearances of most of the tissues were sufficiently altered to cast doubt upon the exact meaning of several of the finer cellular changes observed. For this reason the cellular changes are not dwelt upon in this summary.

Air Passages, Anterior Parts of Middle Meatus and Inferior Meatus of Nose.—A successful section made through the air passages of the rat used in Experiment 12 showed very little alteration in the mucous membrane, but the passages were obstructed by mucus containing many desquamated epithelial cells and a few red blood corpuscles. This animal had lived four days.

Larynx.—In cases in which death had supervened rapidly, no marked edema or desquamation of the epithelium was observed, nor was the mucous membrane covered by coagulable exudation in either the supraglottic, infraglottic, or glottic region. In animals that had lived more than twelve hours there was evidence of catarrhal laryngitis and tracheitis, but the lesions were not extensive.

The surface of the mucous membrane was free from exudation capable of causing obstruction. In one animal which had lived ten days, the mucous membrane of the trachea was covered at places with a fairly thick smooth layer of mucus containing many small round cells and nuclei apparently derived from

epithelial cells broken up in consequence of mucous degeneration. This exudation was most abundant over the openings of the tracheal mucous glands, and was firmly attached to the ciliated surface of the epithelial cells. The lungs of this animal were congested but free from hemorrhage, collapse, or pneumonic changes.

Lungs. — Considerable dilatation of the branches of the pulmonary artery and of the alveolar capillaries was a feature common to all cases. In animals which had died a few hours after exposure, there were patches of hemorrhagic infiltration in various parts of the lungs, and dilatation of the alveoli in intervening parts. Most of the small and terminal bronchi were contracted, but the bronchial epithelium appeared generally to be intact. In one guinea-pig which had lived eighty-eight hours after exposure (Experiment 13), clear evidence of catarrhal bronchitis was found. In a rat (Experiment 12) which had lived nearly four days, the lungs were distinctly edematous, many of the alveoli being filled with a clear exudate free from cells or fibrin.

For reasons already stated no confidence is placed upon the minute cellular changes which may be present in the liver or kidney. It appeared, however, that in animals dying early the liver cells showed a marked tendency to excessive vacuolation, while in the animals that had survived a few days the cells appeared to be smaller than normal. No trace of fatty degeneration of the liver was discovered in any of the cases. Considerable congestion of the liver and kidneys was a common feature. The rod-like structure of the basal part of the epithelium lining the convoluted renal tubules was generally more distinct than normal. There was no evidence of fatty degeneration of the kidneys.

General Summary of Experimental Results

Death is frequently brought about either by the inhalation of air charged with arsenic trichloride fumes or by the direct application of undiluted arsenic trichloride to the skin. In both cases there is clear evidence that arsenic is absorbed by the tissues and that it becomes widely distributed in a very short time.

When arsenic trichloride is applied to the skin it produces necrosis very rapidly. Free washing with water of the part affected within one minute retards the action of the escharotic, and a certain amount of inflammatory reaction is observable in the parts adjacent to the affected region. Even after such washing, however, the whole of the part to which arsenic trichloride has been applied undergoes complete necrosis. Washing five minutes after application has no appreciable effect. A considerable amount of arsenic is rapidly absorbed by the tissues and after a few hours arsenic can be recovered from most of the tissues or organs of the body. There is noticeable a tendency to accumulation in such organs as the brain, liver, and kidneys.

The application of arsenic trichloride to the skin is obviously acutely painful, but the part affected becomes rapidly insensitive. It is doubtful, therefore, whether pain is a determining factor in the lethal action of arsenic trichloride applied to the skin. The fatal effect appears to be due to acute arsenicism.

When air charged with arsenic trichloride is breathed by mice for five minutes, death follows in a few minutes when the air, whether dry or moist, contains 1 part of arsenic trichloride to 40,000 parts of air. When a stream of air charged with arsenic trichloride is

admitted to a chamber containing an excess of ordinary air, animals kept in the chamber are affected variously. Some die after a few hours; others survive for several days and appear to recover entirely. In one experiment, of two guinea-pigs which were at a very short distance (a few inches) from each other one died in less than five hours, and the other lived ten days (Experiments 5 and 6). In another experiment conducted under the same conditions, except that the flow of charged air was less rapid and the exposure twice as long, both guinea-pigs made a complete recovery (Experiments 7 and 8).

These differences were caused by the unequal distribution of the mixture, which was due not only to the formation of an air stream between the inlet and outlet of the chamber, but to the reactions which took place between the arsenic trichloride, water, and the oxygen of the air. As will be shown in a later section of this paper, various motions are caused by these changes. After a few observations it was found that on both sides of the inlet of the chamber there was an area to which the arsenic trichloride fumes found slow access. The fumes were most abundant in the upper part of the chamber at a distance of 30 to 50 cm. from the inlet and were fairly, though less, abundant in the outlet half of the chamber including parts at the sides of the outlet corresponding to parts at the sides of the inlet where fumes were scanty. This observation was confirmed by an experiment in which a rat exposed at one side of the *inlet* (Experiment 11) was not much inconvenienced and was well ten days after exposure, while another rat (Experiment 12) exposed at the same time at one side of the *outlet* was almost immediately severely affected, and died in less than four days.

All the animals that died from the effects of the inhalation of arsenic trichloride showed marked symptoms of respiratory affection. In the animals in which death supervened rapidly the symptoms pointed distinctly to laryngeal obstruction, and death was clearly due to asphyxia. Postmortem examination did not reveal any organic cause of obstruction, such as plugs of mucus, false membrane, or edema glottidis.

The absence of organic obstruction, the extreme rapidity with which death followed after inhalation, and the suddenness of the onset of asphyxial symptoms point to the conclusion that laryngeal obstruction was due to spasm of the laryngeal muscles. The tendency to this spasmodic closure of the glottis continued after the animals had partly recovered, and a fatal ending was produced in a mouse (Experiment 19) as a consequence of its being slightly disturbed: it was breathing with some difficulty but was in no immediate danger; on being slightly disturbed, however, it made violent efforts to breathe, passed into convulsions, and died within two minutes. A guinea-pig (Experiment 12) which appeared to be recovering was liable to violent attacks of dyspnea, followed by convulsions, whenever it attempted to eat solid food or to drink.

Bubbling through a thin layer of water or filtration through a wet sponge deprives the air of the irritating properties giving rise to these laryngeal symptoms. The filtered air still contains arsenic though in smaller proportion than the unfiltered air. It contains much less chlorine, however, so that the irritation of the mucous membrane is probably in great part due to hydrochloric acid or some other chlorine compound. (The water squeezed out of the wet sponge is strongly acid.)

The hair of all the animals exposed to

arsenic trichloride fumes became rapidly laden with a considerable amount of arsenic. This was observed in animals that recovered as well as in those that succumbed to the effects of exposure. The poison was not only deposited on the surface but penetrated into the substance of the hair. This was clearly demonstrated by examination of the solution used for washing the hair, and of the products of disintegration of the hair when it was boiled in 30 per cent. hydrochloric acid. This impregnation of the hair does not appear to have any quantitative relation to the symptoms of poisoning, and the reason for examining the hair of persons and animals exposed to arsenic trichloride fumes was to ascertain the extent of the exposure. During life an examination of the urine and feces is necessary to determine whether such an exposure has led to absorption.

(To be continued)

REPORT OF THE ASSOCIATION OF CERTIFYING FACTORY SURGEONS, INC. (GREAT BRITAIN), FOR THE YEAR 1921

THE last Report emphasized the wisdom of every certifying surgeon who holds an appointment which he regards of some value, making a point of becoming a Fellow or Member. Owing to the excellent financial position of the Association it has not, up to the present, been found necessary to advance the subscriptions, and with anything like a fair response to the appeal, this contingency will not arise. When non-members receive the same benefits of united action as members, it is surely not going too far to suggest to the former the reasonableness of giving their support and sharing the small expense.

Departmental Committee on Blindness

The Hon. Secretary was invited by the British Medical Association to give evidence on behalf of that body on the industrial aspect of defective vision, and did so on 22nd March. The evidence itself cannot be dealt with until after publication of the report, but it may interest members to know the headlines. The first portion had concern with the large number of young persons with uncorrected errors of refraction who seek employment in factories, and with the particular discrimination exercised by certifying surgeons when required to give certificates in such occupations as the machining of wearing apparel, textile spinning, weaving, doubling, winding and reeling, working in iron, steel and other metal, sawing timber, wood working, machine boxmaking, flint glass and pottery processes, all of which require a considerable amount of acuity of vision on the part of the operator.

Alteration in Annual Report

By instruction of the Council a letter was addressed to the Chief Inspector of Factories on 7th March, drawing attention to the circumstance that no particulars respecting conditional employment had been asked for as part of the two previous Annual Reports. (Sec. 64 (5) F. & W. Act, 1901.)

The views of the Association were explained as follows:

It appears to the Association that Sec. 122 (6), F. & W. Act, 1901, requires a record of all young persons ascertained by medical examination to be physically defective, and of the action taken by the certifying surgeon with respect to such. The word "results" is used, and as this signifies more than rejections a return confined to these cannot cover the obligations.

Apart, however, from the strict legal requirement, it is considered of public interest that a full record of the "results" of these medical examinations should be available. The system of conditional certificates, in spite of its imperfections, is regarded as having greatly extended the usefulness of the certifying surgeon, and as being of proved benefit to large numbers of young people on commencing their industrial career.

I have to point out that the action taken by the certifying surgeon, as a result of the defects found, depends as a rule more on the nature of the industry and its capacity for providing suitable alternative employment than on the nature of the bodily disease or infirmity *per se*, so that any particular defective may be totally rejected at one factory and certified conditionally at another. The bulk of defectives may therefore be said to be of one class, dealt with in two different ways according to varying circumstances. The incomplete return at present asked for cannot possibly give any idea of the discrimination exercised in dealing with these young people, and is therefore unfair to the surgeon as well as misleading to the public.

Whilst the former publication in your Annual Reports of a complete summary of conditions attached to certificates of fitness has undoubtedly served a useful educative purpose, in view of the labour entailed in compiling the table, the Association does not press for its renewal. On the other hand, it is respectfully suggested that a full classification of all those found affected with disease or bodily infirmity should be published under two divisions, *viz.*, (1) rejections, and (2) certified conditionally. This would simply mean the adding of a third column to Table II.

The Chief Inspector expressed through Dr. Legge his agreement with the views of your Council, and further suggested that it would be well, when altering the form of report, to revise the list of medical reasons for rejection, and that in any such revision the Association might usefully co-operate with Dr. Legge. The old classification has always been regarded as unsatisfactory by the Association, the consequence being that for many years it was considered necessary to compile its own statistics from special returns by members. As it is a considerable time since an alteration was asked for, and then unsuccessfully, it is particularly gratifying that the suggestion on this occasion should come

from the Department. Your Hon. Secretary had several interviews and some correspondence with Dr. Legge, which resulted in the adoption of a new and concise form of return which would show the complete results of the examination and at the same time not overload the certifying surgeon with book-keeping. The improved form of return was distributed at the end of the current year, but a number of certifying surgeons had been advised of the impending change some months before this. In order to assist members the Council has devised a simple method of keeping records which, with the minimum amount of calculation at the year's end, will provide the Department with all the information required. A large number of these record forms have been printed by the Association and bound together into various sized booklets to suit the varying annual numbers examined by those members who have adopted the system. The cost of the booklet varies, according to size, from 1s. to 4s. 6d., and members desiring replicas should communicate with Mr. Chambers.

Joint Interview with the Chief Inspector

A letter, dated 1st March, was received from the British Medical Association conveying the information that complaints had been received respecting the inadequacy of the fees paid to certifying surgeons, and that the question had been referred to the Medical-Political Committee, which had in turn recommended the Council to co-operate with this Association with a view to getting the fees improved. Particulars were asked of the steps already taken or which it was proposed to take to this end. Details of the action taken by this Association during the past year were duly supplied, along with copies of correspondence with the Factory Department and of the two revised scales of fees issued by the Home Secretary.

It was ultimately agreed that the correct policy would be for the secretaries of both Associations to talk the matter over with the Chief Inspector of Factories. An appointment was made, and Dr. Cox, Dr. Lord, and your Hon. Secretary met the Chief Inspector and Dr. Legge, on 2nd June, at the Home Office. It was recognized by all parties, in view of the existing industrial depression, the urgent necessity for all-round economy, and the fact that the fees for certifying and examinations under special rules and regulations had recently been revised, that very special reasons must be advanced to warrant a further amendment of the minimum scales. Your Hon. Secretary pointed out, however, that the alterations made had apparently not resulted in the increased earnings anticipated by the Home Secretary when issuing his orders. This is due to the fact that the basic fee for a visit had not been taken into consideration, as had been the case when visits to the factory were first instituted, and this resulted in the actual fee paid remaining as before unless more than two patients were examined. Dr. Cox further stated that the net results showed that certifying surgeons' fees had not been increased to the same degree as those paid to other medical men employed by Government Departments. Dr. Cox further promised to supply a list of revised fees paid by other Departments, and this promise has since been carried out. Nothing further has transpired in connection with these representations since the interview.

Discussion also took place on representations made by this Association in the letter forwarded on 7th March to the effect that the compulsory provision of first aid and ambulance equipment in certain factories cannot be expected to achieve the desired results owing to the absence of further provision for medical supervision and direction. Dr. Cox was of the opinion that such a state of affairs might lead to unqualified practice and that the requisite supervision could be readily provided by a works doctor or the certifying surgeon for the district. This Association had recommended that it should be made obligatory upon the employer to obtain, every three months in the case of works employing 500 or more persons, and every six months where less than this number were employed, a certificate to the effect that the provision made was suitable and sufficient. Dr. Legge mentioned that Form 924, Part 10, strongly recommended occupiers to arrange for some form of medical supervision of first-aid boxes and ambulance rooms, and suggested that, where medical treatment was not provided, arrangements for supervision might be made with the certifying surgeon. It was pointed out, however, that dependence cannot be

placed on purely voluntary effort. The suggestion that opportunity should be taken of any fresh legislation to introduce provision for this necessary supervision was favorably received.

Future of the Certifying Surgeon

In the report on reconstruction of the Factory Medical Service, your Council promulgated a practical and economical scheme for effective medical supervision of factories. It has always consistently maintained that the only way to deal with the appalling amount of industrial sickness and mortality is by abolishing the unhygienic conditions of occupation, that it is a Government obligation to create the necessary medical supervision in the factories themselves with a view to establishing the faults and devising the remedies, and that the certifying surgeon could be made into an extremely useful adjunct in the carrying out of a properly thought-out plan of action. Industrial preventive medicine is a branch of State medicine, and must be taken in hand by the State if it is to prove universally effective. The Factory Department's introduction of the medical element into the study of specific dangerous trades has had remarkable results in this country, but not without being followed up by statutory notifications and regulations as well as by a considerable amount of useful work by the factory surgeon. It would, therefore, appear quite logical to infer that similar machinery and methods are required to *prevent* certain well-known general diseases from singling out particular industries for their most extensive ravages and heaviest mortalities. The relief afforded by State provision of medical attendance and sanatoria diminishes the suffering but has little effect on the number of sufferers. Laboratory investigation and the medical examination of adult workers, so extensively advocated in some quarters, will not in themselves bring the goal substantially nearer.

Sad as it may seem, however, there appears to be no doubt that the Government is, for financial reasons, in no position at the present time to undertake any extension of existing obligations; and so far as concerns the certifying surgeon from the official standpoint, indications are in the direction of his remaining *in statu quo* for some time to come.

As the State is not in a position to take in hand this problem of excessive industrial mortality, it would appear to the interests of this Association to keep in touch with the efforts being made to induce employers to take action voluntarily. Whilst it is beyond doubt that only the State can reach every industry and every employer, voluntary effort within its manifest limitations has done and can do great good; even as a tentative measure it has its undoubted attractions, one of the most pronounced of which, from an employer's standpoint, is its promise of increased industrial efficiency.

The welfare movement, which is to a very large extent voluntary, has made great headway and has come to stay. The rapid rate of progress may be measured to some extent by the fact that those interested in the work have already banded themselves into two very active societies, each publishing its own journal. The Welfare Workers' Institute is the organization of those actually engaged in the work of welfare supervision, whilst the Industrial Welfare Society appears more particularly to serve the objects of employers and others interested in welfare propaganda work generally. There is also established the Institute of Industrial Administration, which includes among its activities both industrial medical matters and welfare. Another important society is the National Institute of Industrial Psychology, which is devoting certain of its energies to the study and expounding of the subject of vocational selections from the psychological standpoint, and has associated with it a number of eminent scientists.

Whilst in this country the various bodies mentioned are all, within their respective orbits, very busy in their efforts to improve the lot of the industrial worker, it must be borne in mind that America has for some time led the way in voluntary action. The industrial physician is a well-established entity in the United States; indeed, it is estimated that of thirty-nine millions of industrial workers eight millions are under the influence of medical supervision. In a considerable proportion of the works concerned the industrial physician adopts the complete plan of dealing with the problems of ill-health from the preventive as well as from

the curative side and many establishments are thoroughly equipped with hospitals, sanatoria and research laboratories.

However little likelihood there may be of any early alteration in or extension of the statutory duties of the certifying surgeon, there is no doubt about the unofficial efforts being made to influence public opinion in the direction of medical supervision by the American method, *i.e.*, the wholesale establishment of the industrial physician, or works doctor as he is called over here. During the past year a committee of one of the organizations mentioned was understood to be holding an exhaustive inquiry into the duties, status, salary and conditions of service generally of the works medical officer, with a view to making representation to "the proper authorities" on what the position should be. Another of these bodies has held industrial medical service conferences and, it is understood, intends to hold such conferences systematically in different parts of the country; this body is also strongly advocating medical examinations at all ages.

Up to the present time the institution of the works doctor has not been advocated as a substitution for the certifying surgeon; consequently it does not require a too analytical temperament to recognize that if these appointments are made to any great extent a very objectionable overlapping must ensue. Obviously, then, the correct way to avoid overlapping is for the certifying surgeon to intimate his willingness to take on the additional duties of the works doctor whenever suitable arrangements can be made. Whole-time appointments would, of course, be outside his scope, and so would part-time appointments requiring a major portion of the surgeon's time, but as the present move is not confined to large works, but is meant to bring in the medium and smaller ones, it would appear that the certifying surgeon, who is continuously in his district, who is regularly visiting factories for statutory purposes, and who has the requisite knowledge of occupational risks, dangers, and unhygienic conditions, would be the proper person to take up the bulk of this new work. There are, of course, some certifying surgeons in important industrial districts who could not under existing circumstances spare the additional time, and these surgeons would have to consider very seriously whether, in case of necessity, it would not be the correct policy to balance matters by giving up a proper proportion of their districts. The Council is not anticipating that employers generally will show any alacrity to take up a fresh policy of this nature until a revival of trade justifies them financially, but it does hold strongly to the view that members must keep alive to the possibilities of the movement and be ready to take on any of this work when opportunity presents itself.

Attention was directed in the last Annual Report to the wisdom of co-operation with the Welfare Supervisor, and the Council is convinced that every certifying surgeon should exert himself to the utmost in this direction. The present-day importance of the certifying surgeon is not so much concerned with his absolute power to reject applicants for employment outright, as with his discretionary power to grant certificates under express conditions. This certifying of the child, or young person, for a class of employment suitable to his health and physical powers, which was strongly advocated by the old Association of Factory Medical Officers fifty years ago, was commonly, though unofficially, practised long before it became a statutory function in 1901, and the system was first expounded internationally by the Hon. Secretary of this Association at the second International Congress on Diseases of Occupations, held in Brussels in 1910. The manifest advantages which first became evident to the practical mind of the earlier certifying surgeons have latterly been very extensively paraded under the new and rather more imposing mantle of occupational orientation or vocational selection. The weakness of the system as practised in this country has always been due to the want of any provision for making certain that the conditions attached to the certificates would be carried out. Again practical experience has indicated the proper course to effect a remedy, this time by way of the Welfare Supervisor. This officer has the same relationship to the certifying surgeon as the nurse has to the practising physician or surgeon. Where the necessary co-operation has been arranged, the Welfare Supervisor sees to the proper accommodation for the examinations, takes charge of the general register, makes the required entries at

the proper time, collects the birth certificates, has the examinees ready for the surgeon on his arrival, gives any required assistance during the examinations, and, above all, makes careful note of the conditions and recommendations attached to the certificates, with the object of making certain that they are carried out. It is also an easy matter to arrange for re-examinations. This co-operation is not difficult to arrange, as it is almost universally the case that factories extensive enough, or sufficiently up to date, to have taken up welfare work, make a point of contracting with the certifying surgeon for weekly visits. Should there be found a firm which has adopted welfare without having a contract with the certifying surgeon, the latter should arrange with the supervisor for both to make representations respecting the advantages to be gained by these weekly visits; and where the converse obtains the surgeon should do his best to convert the management to the welfare movement. Co-operation is in some instances carried much further. The re-examination is extended to those between 16 and 18 years of age, and is made more complete, the employer, of course, materially increasing the contract fee. In view of the reduced number of examinations due to age limitation and other reasons, the Council strongly recommends this extended arrangement.

The action taken by the Council with respect to medical supervision of first-aid and ambulance equipment has been explained earlier in this Report. Apart from what legislation may do in the future, we know that the Department would heartily approve of voluntary arrangements being made with the certifying surgeon to undertake this duty. The Council has also every reason to believe that this supervision would be very welcome to Welfare Supervisors who are not already enjoying the exceptional privilege of working alongside a works doctor. Welfare Supervisors are well aware that first-aid in a factory is by no means confined to the preliminary dressing of wounds. All kinds of ailments are brought to their notice, and it cannot but be a distinct advantage to them, as well as to the worker and his employer, to have the benefit of medical advice in dealing with these. It should also be pointed out that the certifying surgeon can be, and has been, of very welcome assistance to Welfare Supervisors by giving addresses on some useful subject in connection with their work at the branch meetings of the Institute, which are regularly held during the winter months in various centres. The Welfare Workers' Institute publishes the excellent monthly *Welfare Work*, which might be subscribed to by every certifying surgeon with advantage. The moderate sum of five shillings annually, sent to Gloucester Mansions, Cambridge Circus, Shaftesbury Avenue, London, W.C.2, will secure regular delivery of this extremely useful periodical.

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Manuel d'Hygiène. By *Dr. L. Guiraud*, Professeur d'hygiène à la faculté de médecine de l'Université de Toulouse. Quatrième édition entièrement remaniée et très augmentée par Le Dr. Albert Gautié, Directeur du Bureau Municipal d'hygiène de Toulouse. Paper. Volumes I and II, pp. 1280 with preface, introduction, table of contents, and index. Paris: Masson et Cie., 120, Boulevard Saint Germain, 1922.

Bibliography of Hookworm Disease. Publication No. 11. Paper. Pp. 417 with preface, introduction, and index. New York: International Health Board of The Rockefeller Foundation, 1922.

Animal Parasites and Human Disease. By *Asa C. Chandler*, M.S., Ph.D., Instructor in Biology, Rice Institute, Houston, Texas. Second Edition Revised. Cloth. Pp. 572 with index, introduction, and bibliography. New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Limited, 1922.

Harvard Health Talks. The Causes of Heart Failure. By *William Henry Robey*, Assistant Professor of Medicine in Harvard University, Visiting Physician to the Boston City Hospital. Cloth. Pp. 45. Cambridge: Harvard University Press; London: Oxford University Press, 1922.

Personal Hygiene Applied. By *Jesse Feiring Williams*, A.B., M.D., Associate Professor of Physical Education, Teachers College, Columbia University. Cloth. Pp. 412 with preface and index. Philadelphia and London: W. B. Saunders Company, 1922.

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THE CONSEQUENCES OF MYOPIA AS AN INDUSTRIAL DISEASE OF THE EYES*

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THE outstanding feature of work in London is the immense amount of close eye work involved both in clerical positions and also in professional and technical work, such as that done by teachers, dentists, compositors, and skilled manual workers at the bench. It is a matter of common observation that continuous close work engenders fatigue, and that the liability of damage to the eyes is increased where there exist errors of refraction or of muscle balance. In some cases there occurs a breakdown in the ability of the worker to continue his work, and this results in a loss to the worker himself, to the employer, and to the community. Besides the liability to breakdown there is a lesser degree of crisis, one which makes the worker less efficient in his job; he continues at work, but the work done is inefficient as compared not only with his own standard under previons conditions of health, but also with the standard of other normal workers. Workers who have experienced either breakdowns or impairment in their ability desire to obtain a change of work if possible, even at some loss of earning power. For the most part, however, they return to work after an interval of rest, and, by reason of their physical disability, join the group of inefficient workers who follow a "ca' canny" policy.

The economic loss and the suffering involved in these cases, and the unhappiness which failure engenders in the mind of willing workers, are so great that we should attempt to prevent them. By suitable means persons likely to fail could be picked out before they made a choice of their life work, and their energies could be diverted into more promising channels.

In presenting evidence before the Committee on the Causes and Prevention of Blindness in 1920[1], I gave an account of the causes of blindness in 925

*This paper was read at the Congress of the Ophthalmological Society of the United Kingdom, May, 1922. Received for publication July 5, 1922.

[1] Harman, N. B.: The Causes and Prevention of Blindness, Based upon an Analysis of 4,288 Cases. *Brit. Med. Jour.*, 1921, 2, 727.

private patients, and showed that the consequences of high myopia, over 10 D, accounted for 13.93 per cent. of blindness, thus occupying the second highest place among all causes of blindness, and the highest among irremediable causes. Very many of these patients had been engaged in clerical work during their working life.

In order to determine whether myopes engaged in continuous close work are exposed to any greater liability to breakdown or grave defect of vision than are myopes not engaged in such work, I investigated the records of about 7,000 private patients. These patients were from all classes of life and from varied occupations. From these records there were picked out all the myopes of over 3 D who were between the ages of 20 and 60 years. Cases of congenital defect, accident, or disease unconnected with myopia, and of monocular myopia were excluded. The total number of myopes thus collected was 480—quite a sufficient volume of material to allow reasonable inferences to be drawn. They were separated into two main sections: (1) habitual close eye workers; and (2) those not thus engaged. In each section there was an age grouping in decades, and also a grouping according to the grade of myopia—from 3 to 5 D, from 5 to 10 D, and over 10 D. In cases of astigmatism the average of the four meridians was taken as the degree of myopia. Note was made of the events of the patient's working history; of the occurrence of indications of abnormal stress in work; of breakdowns which entailed cessation of work, or change of work where that was possible, or a continuance of the same work under modified conditions; and, lastly, of direct evidence of damage to the eyes. The results thus obtained from the examination of these patients and from the comparison of the two sections — the habitual close eye workers and the other patients who were not close eye workers — are presented in Tables 1 and 2.

Of the 480 myopes whose records were investigated, 38 per cent. were engaged in habitual close eye work, and 62 per cent. were other patients not occupied in continuous close eye work. The higher percentage of the second group is accounted for by the fact that it included a large number of married women, and also most of the very high myopes who were prohibited from doing close eye work. The extent of failure among the habitual close eye workers as compared with the other patients is remarkable. No less than 53 per cent. of the close eye workers failed at some time during their career; of these, 15 per cent. sustained permanent damage through the loss of an eye; and two persons lost the sight of both eyes. Among the other patients failures were few, only a total of 9.4 per cent.; but among these the greater number, 7 per cent. (these were very high myopes), sustained damage to their

TABLE 1.—GROUP COMPARISON OF PERSONS HABITUALLY ENGAGED IN CLOSE EYE WORK AND OF PERSONS NOT SO ENGAGED

Type of Patient	Number	Breakdowns	Damage to Eyes	Total of Failures
Habitual close eye workers ..	183	70	27	97
	100%	38.2%	15%	53%
Other workers ..	297	7	21	28
	100%	2.4%	7.06%	9.4%
Total % in 480	100%	16%	10%	26%

eyes; four of these persons lost the sight of both eyes.

The second table shows that there was a gradual increase in the incidence of breakdowns and damage to the eyes with the increase in age and in the grade of myopia. In the group of patients not engaged in close eye work there was only one case of damage to the eyes and no instance of breakdown more numerous among the habitual close eye workers, but it will be noted that there was a higher rate of damaged eyes than of breakdowns among the other patients. This is accounted for by the fact that this section contained most of the very high myopes, who had been warned against doing close work, and many of whom had doubtlessly been saved by attention to this warn-

TABLE 2.—COMPARISON OF HABITUAL CLOSE EYE WORKERS AND OF PERSONS NOT SO ENGAGED, GROUPED ACCORDING TO AGE AND TO GRADE OF MYOPIA

Ages	20-30			30-40			40-50			50-60			Totals for Type and Degree of Myopia		
Degree of Myopia and Type of Patient	Number	Breakdowns	Damaged	Number	Breakdowns	Damaged	Number	Breakdowns	Damaged	Number	Breakdowns	Damaged	Number	Breakdowns	Damaged
3 to 5 D															
Habitual close eye workers	30	8	—	21	9	1	11	2	1	9	2	1	71	21	3
Other workers	43	—	—	25	—	—	31	—	—	17	—	1	116		1
5 to 10 D															
Habitual close eye workers	30	14	2	26	14	2	13	7	2	12	5	3	81	40	9
Other workers	32	—	1	27	1	1	33	1	1	26	1	1	118	3	4
Over 10 D															
Habitual close eye workers	5	1	3	9	2	4	9	4	4	8	2	4	31	9	15
Other workers	11	—	—	15	1	2	16	—	4	21	3	10	63	4	16
Totals for ages	151	23	6	123	27	10	113	14	12	93	13	20	480	77	48

at any age among those with myopia of less than 5 D. Among the habitual close eye workers with myopia of less than 5 D, however, there were a number of cases of breakdown, and a few instances of damage to the eyes. The number of cases of breakdown and of damage increased rapidly for the close eye workers with 5 to 10 D of myopia, for it was in this group that they were most numerous; but there were only a few failures among the other patients with the same degree of myopia.

Breakdowns and damaged eyes (except for the age group, 50-60) were ing. Some of them had such high degrees of myopia, however, that damage was almost inevitable.

The character of the damage sustained was as follows: detachment of the retina, 14 cases; degeneration of the macular region, 34; gross vitreous hemorrhages and the damage consequent thereon, 5; rapid myopic cataract, 3. It is noteworthy how much more serious is the risk of loss of central vision from degeneration of the macula in these myopes, than is the risk of detachment of the retina. Happily, loss of the macula does not leave them in

such a hopeless state as does detachment of the retina. Only six cases of total loss of vision in both eyes were recorded; but in many other cases with the total loss of central vision of one eye, there was also a considerable diminution of the vision of the other eye from the same condition of macular degeneration.

The work done by some of the habitual close eye workers was sometimes of an incredible nature. One person with 17 D of myopia was engaged as a printers' proofreader and corrected statistical tabular matter all day long; another with 12 D was a miniature painter; and yet another with 10 D was a dental mechanic. Some of the close eye workers had made a change of work on their own account: two lawyers forsook their clients, one to become a farmer, the other to become a cinema controller; the miniature painter took over the management of a depot; and the mechanical dentist became a shop assistant. The proofreader, however, preferred to continue and take the risk.

The lesson of these figures is plain enough. No matter what view we may hold of the causes of myopia, it is certain that the risks of myopia are heaviest with the patients whose occupations entail habitual close eye work. The liability of damage to one or both eyes in close work is so great that we are in duty bound to prevent young people, who are affected by myopia of more than the lesser grades, from entering work of this kind; otherwise, a high percentage of them may sustain partial blindness.

THE COMPARATIVE EFFICIENCY OF THE CIRCULAR KONIMETER AND THE PALMER WATER SPRAY APPARATUS FOR THE DETERMINATION OF THE DUST CONTENT OF THE AIR*

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Introduction

ASIDE from the Palmer water spray sampling apparatus (1), the two other devices in general use in the United States for the determination of the dust content of air have been the sugar-filter method and the Hill dust counter. The latter method collected only the very large particles, and the former was difficult to use with accuracy, so that the Palmer apparatus was recommended for general use in 1917 by the Committee of the American Public Health Association on Standard Methods for the Examination of Air (2), and has been extensively utilized by many observers since that date.

During the last few years notable improvements have been made in the sugar filter (3) (4), chiefly by the use of a container holding a much larger volume of the filtering medium. Meanwhile, also, the experts of the Miners' Phthisis Prevention Committee of South Africa (5) have introduced a new device, the konimeter, which is an impingement method like that of Hill, but immensely superior, because it involves the use of an air current of sufficient velocity to secure the retention of the fine particles of dust which are not held back by the dust counter.

In view of these recent advances, it seems important that the whole question of atmospheric dust analysis should be reconsidered, and a careful comparison made of the efficiency of the several devices now available.

Apparatus Used in the Present Investigation

The investigation here reported involves a comparative study of the Palmer water spray apparatus and a South African konimeter of the new circular type. The Palmer apparatus was of the usual design now so familiar that it requires no comment. The konimeter was of the type described by Katz and Trostel (4), and was constructed by A. F. H. Devers, an instrument maker of Johannesburg.

Measurements of the area of the impinging orifice were made with a micrometer microscope. From the average of nine readings of the diameter the area was calculated to be 0.271 sq. mm. The average of nine observations of the diameter of the piston was 1.767 cm. By means of a needle pointer attached to the bottom of the piston, and a millimeter scale the actual travel of the piston was found to be 3.82 cm. From the diameter of the piston, given above, and the length of the stroke the volume of the cylinder was calculated to be 9.44 c.c.

According to the South African investigators the speed of the stroke should be sufficient to produce at the impinging nozzle an air velocity of 30 to 80 m. per second. Since the efficiency of this ma-

*Based on a thesis presented by the junior author in partial fulfilment of the requirements for the certificate in Public Health of Yale University. Received for publication Aug. 5, 1922.

chine depends on the velocity of the impinging jet, considerable attention was paid to this detail. The principle outlined in Appendix No. 3 of the Final Report of the Miners' Phthisis Prevention Committee of South Africa (5) was adopted. A strip of carbonized paper was fixed in a holder attached to the base of the piston. Resting against this paper was a pointer attached to a tuning fork making 100 vibrations per second. When the fork was caused to vibrate and the piston was released, a curve was produced on the smoked paper. The number of complete vibrations here indicated was equal to the time in hundredths of a second taken for the complete travel of the piston. The length of time required was found in this manner to be 0.70 seconds. This gives at the impinging orifice a velocity of 49 m. per second.[1]

After the calculated velocity and volume of the instrument had thus been obtained, it seemed best to check the volume by actual measurements. A small brass tube was screwed on the outer end of the impinging orifice; over this joint a small section of rubber tubing was fitted and the ends were made tight with sealing wax. The lower ends of two 10 c.c. pipettes were connected with rubber tubing and the upper end of one joined to a glass stopcock and then to the tube fixed on the konimeter. Sufficient water was placed in the apparatus to fill the open pipette and the connecting tubing. Pressure tubing was used and the top of the closed pipette was kept moist. That no leakage occurred could be shown by raising the water level in the closed pipette above that in the open pipette, closing the stopcock and observing the level for half an hour. The fact that the water level remained stationary during this interval indicated that the joint was air-tight.

After the konimeter had been set, the apparatus was connected and the open pipette adjusted so that the water in both tubes was brought to the same level. This level was noted. The konimeter piston was then released, and the water was permitted to rise in the closed arm of the U-tube. During motion the surface of this column was slightly convex. It was found that at the end of the stroke, when the pressure below the piston approximated that above it, leakage occurred around the piston packing, and the water level in the closed pipette could not be maintained till a leveling and reading could be made. The use of the stopcock removed this source of trouble. At the end of the stroke, at the instant that the raised center of the column began to drop, connection between the konimeter and the pipette was cut off by means of the stopcock. The open tube was then raised till the columns of water were again level, and the meniscus of the closed tube was read again. The difference between this reading and the first one gave the volume of air aspirated by the konimeter. If the piston was kept clean and lubricated with a slight amount of powdered graphite, little variation was observed. The average volume of air removed was 9.36 c.c., or 99.15 per cent. of the calculated volume.

When dust samples were taken in places where the air was exceedingly dusty, it was found advisable to reduce the amount of air sampled. In this manner the intensity of the dust spot was kept at such a value that the count could

[1]A new spring was obtained and tested in an effort to increase the velocity, but owing to the uneven rate of travel that it produced, it had to be discarded.

be made with a fair degree of ease. In order to accomplish this it was only necessary to reduce the travel of the piston, and for this purpose several small trapezoids of sheet brass were made. They were of such sizes that, when placed in the line of the piston travel, they would cut down the volume of the air sampled to approximately one-fourth, one-third, one-half, and two-thirds of the total volume of the cylinder. The volume of air sampled was carefully determined with the stops in place and was found to be 2.30 c.c., 3.13 c.c., 4.93 c.c., and 6.46 c.c., respectively.

Methods of Sampling

The bottles used for the Palmer samples were Erlenmeyer flasks. They were scrupulously cleaned in the laboratory and slightly more than 100 c.c. of distilled water placed in each. Heavy caps of wrapping paper were fastened over the rubber stoppers with rubber bands. On arrival at the place where the samples were to be taken the apparatus was set up and connected with an electric light socket. About 40 c.c. of water were then placed in the bulb. If the sampling was not started immediately the intake was protected by a small box cover. The manometer was leveled by means of the attached spirit level. After running for a definite length of time, usually twenty or thirty minutes, the water was drawn into a clean flask, the bulb rinsed two or three times, and the washings added to the sample. The bottles were then recapped and brought to the laboratory.

The circular glass of the konimeter, after being washed, was carefully cleaned with lens paper and was then smeared with a thin layer of white vaseline, by means of a glass rod. The vaseline prepared for medicinal purposes was found quite free from dust, and the small tubes in which it may be purchased are convenient to use. The slide, after being vasefined, was examined under the microscope to make certain that it was free from dust. It was then placed in the konimeter and the face plate screwed on. While we were in the places where samples were taken, it was kept in a small carrying case, except for the few seconds necessary to set and release the plunger and to turn a new surface in place before the orifice, by means of the screw provided for that purpose. A sample was taken at the moment that the Palmer apparatus was started, and every five minutes thereafter throughout the time of Palmer sampling. The only exception to this was in Series D, where the extreme conditions made it impracticable to run the Palmer apparatus over eight minutes, and here konimeter samples were taken at correspondingly shorter intervals. Also in Series D, which consists of very high counts, one of the stops previously mentioned was used in all samples.

General Results

In all, thirty-five Palmer air samples were studied in the present investigation, distributed as follows:

Series A.—Knife-handle grinding and polishing shop (coca-bola wood mainly) ... 9
Series B.—Plier grinding shop........... 8
Series C.—Quiet air in unused laboratory 8
Series D.—Sand-blasting room...........10

The general results are indicated in Table 1. It is evident that the konimeter gives far higher results than the Palmer apparatus. In Series A (wood dust) the ratio of the konimeter count to the Palmer count varied for individual samples from 4.8 to 9.8, and averaged

7.3; in Series B (metallic dust) it varied from 18.2 to 33.8, and averaged 23.4; in Series C (normal air) it varied from 7.0 to 58.0, and averaged 19.5; in Series D (heavy silicious dust) it varied from 1.7 to 7.5, and averaged 2.8.

TABLE 1.—COMPARATIVE DUST COUNTS OBTAINED WITH KONIMETER AND PALMER APPARATUS

Series		Particles per Cubic Foot	
		Konimeter	Palmer Apparatus
Series A	Minimum	852,000	110,900
	Average	2,054,500	281,000
	Maximum	3,377,000	470,000
Series B	Minimum	3,389,000	101,500
	Average	4,882,500	208,000
	Maximum	9,410,000	343,900
Series C	Minimum	270,500	25,800
	Average	733,500	37,500
	Maximum	1,660,000	54,200
Series D	Minimum	6,660,000	2,130,000
	Average	40,676,000	14,394,000
	Maximum	91,500,000	38,650,000

Relative Efficiency of the Two Procedures with Reference to Particles of Different Sizes

In Table 2 are presented data for the konimeter-Palmer ratio, with distinction in regard to the size of the particles counted. It appears that with the particles of a diameter over 10 microns the konimeter is from two to three times as efficient as the Palmer apparatus (with the heavy dust of Series D it gave a lower count than the Palmer). For the particles less than 10 microns in diameter, on the other hand, the konimeter is far more efficient, showing a count from ten to twenty times higher than the Palmer count, except in the case of the sandblast dust where the two methods were more nearly alike.

It seems clear that the ratio between the konimeter and the Palmer count is primarily conditioned by the size of the particles involved. In Series A and Series D, which showed average ratios under 8, over fifteen particles in 1,000 of the dust were over 10 microns in diameter. In Series B and C, in which the konimeter-Palmer ratio was from 19 to 23, less than five particles in 1,000 of the dust particles were over 10 microns in diameter.

TABLE 2.—RATIO OF KONIMETER TO PALMER COUNT FOR PARTICLES OF DIFFERENT SIZES

Series	Type of Dust	Ratio for Particles		
		Under 10 Microns	Over 10 Microns	All Particles
A	wood	8.9	2.1	7.3
B	metallic	24.1	3.8	23.4
C	normal room	20.0	3.5	19.5
D	heavy silicious	2.9	0.9	2.8

Since it is the particles under 10 microns in diameter which are of major sanitary significance, the superiority of the konimeter seems to be reasonably clear.

Sampling Error Involved in the Use of the Konimeter

The fact that the konimeter takes a so-called "instantaneous grab sample" obviously offers considerable possibilities of error in its use. It has already been pointed out that in the present study each konimeter count used for comparison with a Palmer count was based on the average of three to seven individual konimeter fields, a konimeter sample being usually collected every five minutes during the period of the Palmer sampling. Of 198 individual konimeter samples but four showed a deviation of over 100 per cent. from the average of the sampling group to which they belonged, and but forty-two showed a deviation of over 50 per cent. When we consider the average deviation for a

group of konimeter samples taken during a single Palmer sampling procedure we obtain the following results:

3 group samples had an average deviation of........................0–19%
21 group samples had an average deviation of........................20–39%
9 group samples had an average deviation of........................40–59%
1 group sample had an average deviation of........................60–79%
0 group sample had an average deviation of........................80–99%
1 group sample had an average deviation of........................100–119%

On the average, therefore, even a single konimeter sample will generally give a result within 60 per cent. of the average of a series of such samples collected at the same place and at approximately the same time. It would be well, in practice, to take three konimeter samples at a given point at intervals of five minutes, a procedure which would yield entirely representative results with far less labor than that involved in the collection of a single Palmer sample.

Summary and Conclusions

1. It appears from this study that the circular konimeter gives dust counts from two to twenty times as high as those obtained with the Palmer apparatus.

2. The finer the dust, the greater is the excess of the konimeter count over the Palmer count, a fact which weighs heavily in favor of the konimeter, since it is the fine particles which are of chief sanitary significance.

3. Sampling errors due to the small volume of air collected by the konimeter do not appear to be serious. They can be reduced to a negligible value by taking three konimeter samples at a given point at intervals of five minutes.

4. The konimeter is altogether superior to the Palmer apparatus in regard to portability and to economy of time and labor in sampling and counting.

5. It is evident that the whole problem of standard methods for determining atmospheric dust should be reconsidered. Before the konimeter or any other device can be substituted for the Palmer apparatus extensive examinations must be made of air from various types of industrial establishments, since the standards now in use in this country are based on the Palmer method and must be fundamentally revised before practical conclusions can be drawn from the use of any other procedure.

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THE RÔLE OF SYPHILIS IN INDUSTRIAL DISABLEMENT: ANALYSIS OF 291 PHYSICAL SURVEYS*

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THE physical surveys which are reported in this article were made for several reasons. A great many of them were requested by the relief department of a Baltimore company because of unsatisfactory diagnosis, especially in cases characterized by delayed convalescence and prolonged disability. Others were requested by the claim and legal departments in order to determine the extent and character of disablement, if any, for the purpose of settlement. The number of positive syphilitic findings was so great that our attention was attracted to this condition as one playing an important part in, and frequently the entire cause of the disablement.

The diagnosis of syphilis was based on the physical findings, blood and spinal fluid Wassermann test. In the Wassermann test used two methods and two antigens were employed: ice box and water bath methods; and cholesterine and alcoholic antigens. I realize that certain exceptions may be taken to the accuracy of the Wassermann reaction. Until some method without possible error has been developed, however, we must necessarily accept the Wassermann test as performed by an experienced and well-equipped laboratory as 100 per cent. accurate. Whatever error the test has, will be on the positive side, and someone may receive unnecessary treatment. When one considers the dire results from failure of early recognition and from insufficiency of treatment, one cannot but conclude that the minute degree of inaccuracy (less than 1 per cent.) may be ignored for the sake of the greatest good to the greatest number.

Summary of Cases

There were 291 surveys made. The blood was examined for syphilis in 222 cases, of which 187 gave negative results, and 35 positive results. In 69 cases early in the series, we did not make a Wassermann test as we did not then think that it was indicated. Had we done so, I believe that the total number of positive cases would have been larger. Of the total number of patients—that is, 291—we found that 12– per cent. had syphilis. Of those cases in which the Wassermann test was made—namely, 222—15– per cent. gave positive results. In the 35 cases of syphilis we found 32 positive blood Wassermanns, and 3 negative with positive spinal fluid. There were 14 positive spinal fluids, and 2 negative; in 19 cases the spinal fluid was not obtained. In 11 cases both blood and spinal fluid were positive. Twelve patients gave a definite history of syphilis. Nineteen had definite cerebrospinal syphilis; of this number, 14 were trainmen or had to do with the operation of trains; 6 were engineers; 1, a conductor; 4, brakemen; 2, firemen; and 1, a telegraph operator. Five other trainmen had chronic syphilis. Of the 35 patients

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with syphilis, 15 are now permanently disabled; 15 are temporarily disabled; and 4 are dead.

The total amount of time which was lost by these thirty-five employees up to May 1, 1921, was 13,946 days; the largest number of days lost by one person was 2,003, the smallest, 30, making the average 410. The cost to the relief department for the same period was $25,296.10, the cost to the company as compensation, $25,415, making a total cost of $50,711.10.

While we are not in a position to say that syphilis was the sole cause of disablement in all these cases, we can say that where other conditions were complicated by syphilis the original disablement was prolonged directly by the disease, and without exception the problem in each case was to treat the syphilis as a primary means toward terminating the disablement. There were nine cases of injury in the list; the remainder were medical conditions, and of this group twenty-one were cases of definite mental disturbances.

There are several interesting and important questions arising out of a study of this sort. For instance, what measures can we take to help those already disabled; to prevent a continuance of this condition among employees; to guard the safety of the traveling public; and to protect the company property? There are three viewpoints from which the problem may be approached: that of the individual; that of the community and the employer; and that of the consultant physician. The individual will naturally ask: "If I have syphilis, why should there be any delay in making a diagnosis? Can I be cured? If an early diagnosis had been made, would it have had any bearing on the final result of the treatment? Am I a source of danger through contagion to my family or to the public?"

The viewpoints of the public and of the employer are the same, and have to do with the conservation of life, health, and property. The logical questions are again: What is the possibility of contagion? What effect does the disease have upon the capacity of the men as railroad employees? Did any of the workers have syphilis at the time of employment? Can syphilis be detected by the ordinary physical examination for employment? Is there any way of making an early diagnosis in persons acquiring the disease after the entrance examination? Can they be cured?

The medical viewpoint includes all of the foregoing problems with the additional problems of determining when patients cease to be contagious; when they are safe as trainmen; by what standards their fitness can be determined; in what way their entrance into the service can be prevented; how those acquiring the disease after entrance can be discovered; and how efficient treatment can be given those who are unable to pay for it.

In the following I shall attempt to answer these questions, though not categorically. The delay in making an early diagnosis of syphilis is due to laxity or insufficient observation on the part of the medical adviser. I believe that for the most part the failure is due to hurried and careless examinations. Most of these syphilitic cases are entirely under the care of the family physician. He passes on his diagnosis to the medical examiner, who accepts it without further inquiry, and the result is that the *patient* loses his only hope of cure. It must be remembered that in the vast majority of cases the medical examiner has no alternative but

to accept the diagnosis given, as he has no ethical reason for investigation until the disability has extended beyond a reasonable time. Then, in the interest of the relief department, as a mutual insuring agency, he is entitled to ask for further search for the cause of disablement. In trainmen, however, the danger to the life and property of the community demands that every case of suspicious illness — such as lapse of memory, failing vision, continued dizziness, erratic conduct, uncontrolled temper, and especially cases of employees who possess ideas of grandeur, and are prone to boast of their ability and possessions — should be investigated minutely, and syphilis should be borne in mind as a possible cause. Little credence should be given to the absence of positive history. All trainmen who have been disciplined for disobedience of orders in handling trains should not be permitted to return to work until a complete medical examination has been made. All cases of disablement of more than thirty days' duration, unless the diagnosis covering the condition is obviously correct, should be referred for a more complete examination. Certainly, disablement should not be permitted to continue indefinitely without a well-directed effort to arrive at a diagnosis, and thus prevent unnecessary and oftentimes fatal delay in instituting proper treatment.

Stokes and Brehmer, from the immense material of the Mayo Clinic, have reported in THIS JOURNAL[1] a study of syphilis which has a direct bearing upon this discussion. They reviewed the general medical examinations of 1,763 patients, and found syphilis, obvious enough to be detected without laboratory tests, in 3.1 per cent.; 4.2 per cent. of the men had the disease, and 2.6 per cent. of the women. The lowness of these figures coming from a well-equipped clinic emphasizes the weakness of clinical judgment alone, in the recognition of this disease, as compared with the diagnoses based upon the Wassermann test. Of the positive diagnoses, 58.7 were contributed by laboratory procedures. Of the railroad employees examined 11.7 per cent. had syphilis. The disease was eight times as frequent in them as in farmers (1.5 per cent.); three times as frequent as in business men (3.8 per cent); and twice as frequent as in laborers (6.1 per cent.). The doubtful value of the history of infection in the recognition of these cases is shown by the fact that 24 per cent. had no history of infection other than gonorrhea.

The only hope that we have of curing these patients lies in the early recognition and vigorous treatment of the infection. The sufficiency of treatment is to be determined by the blood and spinal fluid reaction, and no one should be discharged as cured until a negative Wassermann on the spinal fluid has been obtained. It must be recalled, however, that while the early syphilitic infection is general, there is a tendency for the spirochetal cause to localize itself in certain tissues, as in the aorta, but more especially in the central nervous system. When the central nervous system has been entered and changes in the tissues have resulted, as evidenced by a positive Wassermann reaction and cellular change in the spinal fluid, we have little to offer in the way of curative treatment and must be satisfied with the arrest of progress of the disease.

Contagion.—All cases of acute syphi-

[1] Stokes, J. H., and Brehmer, H. E.: Syphilis in Railroad Employees. THIS JOUR., 1919-1920, *1*, 419.

lis or those in which there are active lesions should be handled as contagious. In the later stages of the disease, as in locomotor ataxia and general paresis, there is little danger of contagion. These patients are suffering not so much from syphilis as from the destructive action of syphilis on the brain and the spinal cord.

Are Syphilitics Safe as Trainmen?—All syphilitics should be considered potentially unsafe as workers until effective treatment has been instituted and their progress toward recovery carefully followed. It is my firm conviction that all syphilitics with an invasion of the central nervous system should be considered unsafe as trainmen and should not be permitted to operate trains until it is proved that they are cured. They are unsafe as trainmen because of the liability of sudden attacks of unconsciousness, of uncertain memory, of defective judgment and last, but by no means the least, because of the ideas of grandeur that characterize certain cerebrospinal cases.

File No.	Occupation	Age	Social Condition	Original Diagnosis	Wassermann Blood	Wassermann Spinal Fluid	Final Diagnosis	Disablement Complete	Disablement Partial	Time Lost Days	Cost to Company	[illegible]	History of Syphilis
1183	Conductor	55	M	Hemiplegia	Pos	Pos	Arterial Hypertension-Syphilis	✓		463	$963.75	No	No
1006	Blksmith	48	M	Chorea	Pos	Pos	General Paresis	✓		341	2100.00	No	No
1036	Pedestrian	22	S	Ununited Fracture	Pos		Syphilis				5500.00	No	Yes
1267	Fireman	31	W	Unconsciousness Acute	Neg	Pos	Cerebro-Spinal Syphilis		✓	425	20.00	No	Yes
1599	Eng.	60	M	Chronic Syphilis	Pos	Neg	" " "	✓		30		No	Yes
1050	Eng.	49	M	Influenza	Pos	Neg	" " "	✓		232	580.00	No	No
1177	Watchman	42	M	Unconsciousness Acute	Pos	Pos	" " "	✓		2003	2495.00	No	No
1452	Eng.	46	M	Diag. Mental Condition	Pos	Pos	" " "	✓		206	225.00	No	No
1094	Brkman	44	M	For Diagnosis	Pos	Pos	" " "	✓		61	177.00	No	Yes
970	Tel. Opr.	33	M	Loss of Memory	Pos	Pos	" " "		✓	365	17.50	No	No
1368	Blksmith	28	M	Mental Condition	Pos	Pos	" " "		✓	599	916.50	No	Yes
1403	Brkman	38	S	Amp. of Leg Disabled	Pos	Pos	" " "		✓	116	273.00	No	No
1424	Laborer	36	M	Burn of Leg Unhealed	Pos		Chronic Syphilis		✓	75	42.00	No	Yes
1148	Eng.	43	M	Tabes Dorsalis	Pos		Tabes Dorsalis	✓		1125	1796	No	No
1498	Brkman	48	S	Amp. of Leg	Pos	Pos	General Paresis	✓		762	773.00	No	Yes
1491	Fireman	37	M	Colitis	Pos		Chronic Syphilis		✓	114	243.00	No	No
1496	Brkman	51	M	Tabes Dorsalis Aneurism	Pos		Tabes Dorsalis Aneurism	✓		1131	1480.10	No	Yes
58	Cook	48	M	Rheumatism	Pos		Ataxic Paraplegia	✓		76	750	No	No
980	Eng.	44	M	Tabes Dorsalis	Pos		General Paresis		✓	260	550.00	No	No
949	Eng.	50	M	Syphilis	Pos		Tabes Dorsalis		✓	97	374	No	No
636	Conductor	46	M	Neurasthenia	Neg	Pos	General Paresis	✓		502	2276.00	No	No
663	Brkman	39	M	Optic Neuritis	Neg	Pos	Cerebro-Spinal Syphilis	✓		1165	2299.00	No	No
723	Fireman	25	M	Diagnosis	Pos	Pos	General Paresis	✓		457	774	No	Yes
412	Brkman	32	M	Influenza	Pos		Chronic Syphilis	✓		76	195	No	No
813	Fireman	40	M	Injury to Knee	Pos		Chronic Syphilis		✓	149	505.00	No	No
1318	Brkman	37	M	Ununited Fracture	Pos		Chronic Syphilis	✓		500	1749.00	No	No
268	Machinist			Sacro-Iliac Disease	Pos		Syphilitic Osteitis		✓	54	87.00	No	No
1475	Brkman			Contusion of Leg	Pos		Syphilitic Periostitis		✓	89	143.00	No	No
985	Eng.	39	M	Contusions-Delayed Recovery	Pos		Chronic Syphilis		✓	359	881.00	No	No
1550	Laborer	33	M	Rheumatism	Pos	Pos	Chronic Syphilis		✓	119	232.00	No	Yes
1128	Brkman	47	M	T.B. Sinus of Sternum	Pos		Gumma, Chronic Syphilis	✓		2003	2495	No	No
1356	Hostler	45	M	Myalgia	Pos		Chronic Syphilis		✓	82	225.00	No	Yes
850	Brkman	36	W	Fracture of Ribs	Pos		Chronic Syphilis		✓	71	108.00	No	Yes
931	Laborer	44	M	Contusion of Knee	Pos		Syphilitic Osteitis		✓	591	473.00	No	No
1124	Machinist	38		Influenza	Pos		Chronic Syphilis		✓	75	42.00	No	No
							Cost to Claim Dept. $25,415.00		Total	13946 Days	25296.10 $		12 Positive, 23 Negative
							Cost to Relief Dept. 25,296.10						
							Total $50,711.10						

Fig. 1.—Tabulation of findings in thirty-five cases of syphilis.

The following extracts from case reports are cited by way of illustration.

Case 1 (970).—A telegraph operator, aged 33, married, was reported for unsatisfactory service by the Division Superintendent, who

stated that he forgot to deliver mail and baggage and could not copy a Western Union message correctly. The superintendent was afraid that the man would fail to deliver a train order. A diagnosis of general paresis was made on the basis of positive blood and spinal fluid reactions.

Case 2 (1094).—A brakeman, aged 44, married, was subject to hallucinations and peculiar spells. A diagnosis of cerebrospinal syphilis was made; the blood and spinal fluid were positive.

Case 3 (1452).—An engineer, aged 46, married, was reported by a fellow-engineer because of his peculiar actions. The case was diagnosed as cerebrospinal syphilis; the blood and spinal fluid were positive.

Case 4 (1267).—A fireman, aged 31, a widower, became suddenly unconscious in the cab of an engine and fell to the floor, where he remained for two hours. Upon his recovery he had no memory of the attack. A diagnosis of cerebrospinal syphilis was made; the blood was negative, the spinal fluid positive.

Case 5.—J. S., a brakeman, aged 35, married, entered the hospital with the history of having fallen from a slowly moving train; the cause of his fall was unknown. He had a few superficial scratches. His conductor stated that he had reported him several times for inattention, forgetfulness, and general unsatisfactory service. He sent him to bring nine cars from a siding, and he brought out eighteen. When questioned, the brakeman said that he had only nine. He had a penile scar, and gave a history of infection in August, 1921. He had received no treatment. The blood reaction was 100 per cent. positive.

Case 6.—An engineer ran past a signal set against him and a rear-end collision with another freight train resulted. The engineer and fireman were killed. A bottle of mercury tablets was found in the engineer's pocket, and investigation proved that he was being treated for syphilis.

While defective memory may lead to serious loss of life or property, it is not nearly so dangerous from the railroad point of view as the condition generally known as "idea of grandeur," where the person is convinced of his superior intellect and his freedom from the usual restraining customs and orders of his life and occupation. One engineer with syphilis (included in this series) had a boiler explosion; perhaps he reasoned that water in the boiler was necessary for other engineers but not for him. Another engineer with syphilis, with a previous good record, passed a danger signal, thereby wrecking two trains. Perhaps he thought that stop signals were all right for the average engineer but not for him. These examples show that all trainmen with syphilis are dangerous to themselves, to the public, and to the company; and all trainmen who are questioned about their failure to comply with rules having to do with the safety of trains should have a medical examination before they are permitted to resume their duties.

Syphilis at Time of Employment.—It was shown by Stokes and Brehmer that 26 per cent. of the patients with syphilis contracted the disease between the ages of 17 and 20 years; 32 per cent., between 20 and 25; and nearly 60 per cent. previous to 25 years of age. It must be concluded, therefore, that a large number were syphilitic at the time of employment. It is quite obvious that figures with regard to time of infection could not be obtained from industrial sources such as this series which I have reported, yet I feel that the experience of Stokes and Brehmer so accords with my own private experience that their figures can be accepted as applying to railroad men.

Can Syphilis Be Detected by Ordinary Physical Examination for Employment?—Except in very obvious cases detection of the disease is impossible. By a slight modification of the routine examination, however, the number of cases detected can be substantially increased.

In the cases where syphilis is acquired after employment we must depend on publicity propaganda to make the infected persons recognize the dangers of the disease, and to lead them to seek early treatment. I am sure that every man is interested in syphilis, and I am equally sure that those who have any reason to suspect the possibility of disease would seek information if they knew where to find it, and if they were certain that there would be no publicity.

In conclusion I would suggest that in routine examination more attention be paid to the genitalia for scars or other evidence of infection; to pupillary reactions; to absence or exaggeration of deep tendon reflexes; to the presence of pigmented scars over the shins, and to the Romberg test. All persons presenting deviation from normal should be carefully questioned and examined, and, if necessary, a Wassermann test should be made. I realize that there may be some objection to the additional expense entailed in making such examinations. Up to May 1, 1921, the thirty-five cases which I have reported have cost the company over $50,000 in money paid out, and how much more indirectly no one knows. We must not overlook the fact that at this stage these persons are, for the most part, beyond human aid and must necessarily go down to mental breakdown and death, and that nearly all of them could have been cured had their condition been recognized early. This number is but a small percentage of the cases of the disease prevailing in our service. Had we been able to prevent three or four of these thirty-five cases from going on to complete disablement, we would have saved enough money to cover the additional expense of the proposed examination.

I have purposely avoided mention of certain interesting problems, chief among which are those regarding treatment—namely, the sufficiency of treatment as given by the average medical man, and the provision of opportunity for the proper treatment of persons who are unable to pay. I hope that some solution of these problems may soon be offered.

THE PHARMACOLOGY OF SOME PHENYLENEDIAMINES*

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CONTENTS

I. Introduction

Of the various phenylenediamines, the following are the most important for a study of their pharmacological actions and toxicity because of their extensive use in science, industry and the arts: meta-phenylenediamine, para-phenylenediamine, and the dimethyl and diethyl derivatives of the latter. They are used as reagents in the manufacture of dyes, in dyeing furs and pelts, and in the rubber industry, and they cause a peculiar, specific edema of the head and neck. The existing pharmacological studies are incomplete and contradictory, and deal principally with para-phenylenediamine. The dimethyl and diethyl derivatives of para-phenylenediamine have been scarcely studied at all. It seemed desirable, therefore, to repeat and extend the observations on these phenylenediamines. Ortho-phenylenediamine is too toxic for many purposes and has not been included in the present study. Before proceeding to the body of the paper, a review of the literature pertaining to the uses, toxicity, and pharmacological actions of the phenylenediamines will be presented.

II. Literature

Use as Reagents.—Formerly, para-phenylenediamine and its dimethyl derivative, which is more sensitive, were used by the older biologists (1) as reagents for the detection of ozone and peroxides in plant juices and animal cells. This use was based on a color change which these compounds undergo in the presence of oxygen (O_2), namely, from a light straw or no color to blue or violet. This change is rather sensitive, and on the strength of positive tests it was claimed that plant juices and saliva contained peroxides. Serum free from cells fails to give a positive reaction. A positive reaction is also unobtainable after treatment with hydrocyanic acid. Presumably, the intra-

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cellular enzymes (oxidases) are at least in part concerned in this reaction, although the exact mechanism of action has not been definitely ascertained. According to Battelli and Stern (2), blood and all tissues of higher animals possess strong oxidizing powers for para-phenylenediamine; the oxidizing power of the brain, heart, muscles, kidneys, and liver is very intense, while that of the pancreas, spleen, and lungs is very weak. It is claimed by these investigators that the white substance of the brain is more active than the gray substance. The power of oxidation of these compounds possessed by the tissues of many animals is not altogether lost by boiling and by the addition of mineral acids.

In another study on various factors which influence the oxidation process, Battelli and Stern (3) conclude that the oxidation of para-phenylenediamine by animal tissues takes place most energetically in the presence of water, and that the addition of or treatment with acid, alkali, concentrated salt solutions, acetone, and alcohol, retards or inhibits the reaction. Muscle heated to 60°C. is no longer able to oxidize the para compound. Dimethyl-para-phenylenediamine, together with *a*-naphthol, is used as a reagent by histologists to demonstrate the presence of oxidase granules in cells (4). The responses with different cells are so variable, however, that the quantitative feature of the reaction appears doubtful, the differences being presumably due to differences in permeability of cells and carelessness in the handling of specimens in the presence of atmospheric oxygen, which suffices to produce the oxidative change.

Besides their use as reagents, the phenylenediamines are used chemically for the manufacture of indicators and dyes, such as chrysoidine, Bismarck brown, and methylene blue (5).

Poisoning from Hair and Fur Dyes.—Under the name of ursol, para-phenylenediamine is used extensively for the dyeing of furs and pelts. It is also a common constituent of certain hair dyes, and many cases of poisoning from such hair dyes are reported in the literature (6). The other important constituent of this class of hair dyes is iron which, when mixed with para-phenylenediamine, gives a black color. Recently, Thompson (7) observed the following symptoms after the use of the French hair dye, "goute à goute," which contains para-phenylenediamine: vertigo, gastritis, diplopia, asthenia, and exfoliative dermatitis. Knowles (8) reports similar symptoms, including dermatitis, from cosmetics and wearing apparel (furs, stockings, etc.) containing para-phenylenediamine. These reports agree with reports of the older observers, which may be found in works on toxicology by Kunkel, Kobert, and Brouardel (6), and need not be detailed here. In Germany, according to Gerdon (9), para-phenylenediamine, because of its toxicity, is being replaced in cosmetics by the non-toxic aureol.

The commonest afflictions observed among fur and hide workers exposed to dyes containing para-phenylenediamine are asthma and eczema. The cause of the asthma has given rise to considerable speculation. Gerdon (9) and Curschmann (10) attribute the asthma to an anaphylactic reaction. The attacks occur chiefly during the stage of drying the dyed pelts and at a time when they are treated with sand and pulled out of dye containers. These manipulations are accompanied by clouds of dust containing para-phenylenediamine and

its oxidation products, which the workers inhale. Curschmann claims that fur-dye workers become hypersensitive, and become ill even when handling the finished products (dyed furs). Both Gerdon and Curschmann claim that guinea-pigs, which have been injected with serums of individuals suffering from ursol poisoning, respond with severe anaphylactic symptoms when they are reinjected intravenously and hypodermically with the oxidation product, quinonediimine, and also when they inhale it. Their evidences are not convincing, however, since it is now known that numerous foreign substances of diverse nature can cause anaphylactoid symptoms, but not true anaphylactic shock. On the contrary, it appears more probable that the responses in human individuals and in guinea-pigs occur directly and as a result of the marked irritant properties of para-phenylenediamine. This is the view of Sartory and Rousseau (11), and is supported by the results of my experiments. On the basis of animal experiments, Sartory and Rousseau state that the oxidation product, quinonediimine, is pharmacologically inert and is not responsible for the irritant effects of hair and fur dyes containing para-phenylenediamine. In support of the claim that ursol exerts a direct irritant effect on the respiratory passages, the presence of pharyngitis and laryngitis reported by Ritter (12) may be cited. The eczematous appearance of the skin can be explained as being due to a dermatitis resulting from direct irritation by the dye in the same way as dermatitis of the scalp occurs from the use of hair dyes discussed above.

Use in Rubber Industry.—The extensive use of various amino compounds, including aniline and the phenylenediamines, as accelerators in the vulcanization of rubber has been known for some time (13) (14) (15). The following phenylenediamines are reported as being used for this purpose: meta-phenylenediamine, para-phenylenediamine, and dimethyl - para - phenylenediamine (16). Poisoning from the use of aniline in the rubber and other industries is well known (17); from our knowledge of poisoning from hair dyes and in the fur industry, the same result might be expected from the use of the phenylenediamines in the rubber industry. It does not follow from this, however, that the finished rubber product is toxic or injurious as a result of the use of such accelerators, since it is claimed that these compounds are destroyed during the process of vulcanization. On the other hand, the formation of new products just as toxic, or even more toxic, from the contact of rubber and such aniline-like accelerators is possible.

It is stated in the Bulletin of the Bureau of Labor Statistics for 1915 (17) that certain aniline-like compounds, when heated with rubber, form guanidine, a strong muscle-nerve poison which causes increased irritability, convulsions, and other symptoms. Similar symptoms have been recently reported by Stokes and Busman (18) and Busman (19) from the use of gum-rubber tubing in the intravenous injection of arsphenamine and other compounds. Whether the reactions described by Stokes and his associates are due to the presence of the aniline type of accelerator, or to guanidine-like products, is not known. According to some manufacturers, the rubber tubing intended for surgical purposes is not vulcanized with the aid of the aniline and phenylenediamine type of accelerators, but instead of these, hexamethyleneamine is used.

Nevertheless, it is known that accelerators are used extensively, and if any one of the phenylenediamines is used in the vulcanization of surgical rubber tubing, it is potentially toxic and its use is reprehensible. It will be shown by the results of my work that the phenylenediamines are distinctly toxic in very small quantities and concentrations.

Aside from the acute toxicities, the phenylenediamines and products of manufacture requiring their use may conceivably give rise to chronic effects, such as chronic pulmonary and skin diseases, nephritis, and tumor formation. Nassauer (20) reported the occurrence of cancer of the bladder among workmen in the organic chemical industry in which aniline and aniline-like compounds are used. Workmen may be employed for sixteen years before symptoms of the disease appear. On the other hand, tumors were not noted by Nassauer in men exposed to aniline-free benzene for twenty years. It is, therefore, of considerable interest and importance to ascertain the action and toxicity of such compounds as the phenylenediamines, which are chemically closely related to aniline.

Pharmacology.—As far as I can ascertain, the physiological effects of the phenylenediamines were first studied by Dubois and Vignon in 1888 (21). Their immediate interest in these compounds was their chemical resemblance to leukomains and ptomains. Although Dubois and Vignon reported results with the para and meta compounds, there is some doubt about the identity of their para compound, since it was obtained from ortho-nitraniline, which yields ortho-phenylenediamine. There is probably no question about the identity of their meta-phenylenediamine. The symptoms produced in dogs by the injection of 0.1 gm. per kilo of the para(?) compound consisted of salivation, vomiting, diarrhea, diuresis, marked exophthalmos, coma, and death within two or three hours. The injection of 0.1 gm. per kilo of meta-phenylenediamine in dogs caused symptoms resembling those of influenza—namely, continuous sneezing, hoarse cough due to marked irritation of the pharynx and the glottis, marked coryza, increased secretion of mucus and urine, and finally coma and death. At autopsy the lungs and abdominal viscera were markedly congested.

The symptoms of respiratory distress and congestion of viscera observed by Dubois and Vignon were subsequently confirmed by Erdmann and Vahlen (22) by experiments on rabbits and dogs. In addition, Erdmann and Vahlen showed that the administration of para-phenylenediamine to rabbits caused a peculiar specific edema of the head and neck, with marked swelling of the tongue, while the eyelids and tissues of the orbits gave the appearance of exophthalmos. They ascribed the edemas to the irritant action of the oxidation product, quinonediimine. According to these authors, the para-phenylenediamine circulated through the body, was excreted on the surfaces of membranes, and there in the presence of atmospheric oxygen was converted to quinonediimine, which in turn caused irritation and, consequently, edema. This hypothesis, as well as certain results of Erdmann and Vahlen with quinonediimine, was not supported by the totally negative results of Sartory and Rousseau (23) with the oxidation products of para-phenylenediamine in dogs, while the unoxidized compound was definitely toxic.

The edema observed by Meissner (24) was characterized by considerable maceration, with increased viscosity and fibrin content of the blood. Neither section of peripheral nerves with degeneration of the sympathetic fibers nor the administration of reducing agents or of preparations of glands of internal secretion influenced the edema, but the administration of 10 per cent. calcium chloride inhibited it, and atropine completely prevented death and edema of the tongue and head. Meissner concluded, therefore, that the mechanism of action was peripheral and presumably located in the muscles themselves. The blood pressure in rabbits remained unchanged, but the respiration increased during the edema. The dose of para-phenylenediamine by mouth necessary for the edema action was 0.4 gm. per kilo. In frogs three stages of action were observed by Meissner. In the beginning, the action was characterized by a narcotic-like paralysis. Later, convulsions of medullary origin occurred; finally permanent muscular stiffness occurred; and at death the animals appeared in rigor. The isolated heart was not markedly influenced by para-phenylenediamine, while the blood vessels in excised organs were constricted.

In a recent study on the comparative toxicity of several different phenylenediamines and their derivatives, Meissner (25) found that meta-phenylenediamine and dimethyl-para-phenylenediamine did not cause edema in rabbits, and that the ortho compound did so only in c a t s. Diethyl-para-phenylenediamine produced facial and neck edema in rabbits as readily as para-phenylenediamine. Dimethyl-para-phenylenediamine was fatal in very small dosage, and also caused hemorrhagic nephritis in rabbits.

In their experiments with meta-phenylenediamine on two rabbits and one rat, Hess and Müller (26) observed hydrothorax and fluid in the peritoneum, but they do not mention edema in the rabbits. The rat showed facial edema at the end of ten hours. The same effects occurred after the administration of toluylenediamine in dogs and rabbits—effects which Hess and Müller ascribed to increased filtration due to increased permeability of the capillaries produced by these compounds as indicated by the increase in concentration of the blood.

Whatever the true explanation of the peculiar edema may be, the results of my experiments indicate that it is a variable phenomenon. It is most readily induced in rabbits, less readily in cats, and thus far never in rats and guinea-pigs. The dosage necessary for the production of the edema, the character of the onset, and the time of appearance of the edema are also variable. These points will be discussed later in the paper.

According to Erdmann and Vahlen, the dark color of the blood after the injection of para-phenylenediamine in animals is not due to methemoglobin. These investigators claim that there is also a high increase in the ammonia content of the blood.

In man, the effects produced by para-phenylenediamine are analogous to those produced in animals, the symptoms consisting of asthma, eczema, chemosis, gastric irritation, lachrymation, and exophthalmos. By some investigators (S. Fränkel (27), and Erdmann and Vahlen (22)) these effects are attributed to irritation by the oxidation product, quinonediimine. Pollak (28) thinks that the effects are due to para-phenylenediamine. Others (v. Criegern (29), Gerdon (9), Curschmann (10), and

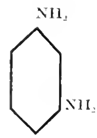
Doerr (30)) attribute the reaction to a true anaphylaxis. The reasons for believing that the anaphylactic view is untenable have already been stated and need not be discussed here. The evidences as to whether quinonediimine or para-phenylenediamine is responsible are conflicting. The literature contains no data regarding the actions of the dimethyl and diethyl derivatives upon man.

Medicinal Uses.—Meta-phenylenediamine was introduced into medicine, under the name of lentin, as an antidysenteric remedy by the chemist, Reidemeister (see Unverricht, 31), on the now obsolete theory that Asiatic cholera was a nitrite poisoning owing to the nitrite producing property of cholera bacilli in the intestine. According to this view, meta-phenylenediamine would bind the nitrite with which it combines readily. Favorable results from its use in diarrheas of different origin were reported by Unverricht (31) and Boye (32). Unverricht and Boye observed a brown coloration of the urine of children after doses of 0.01 to 0.02 gm. of meta-phenylenediamine: and of the urine of adults after doses of 0.1 gm. three times daily. It is claimed that constipative and astringent actions occurred after doses of 0.1 gm. administered to children. On the other hand, in animals, diarrhea occurred—a result which might be expected considering the irritant action of the agent. Since Boye limited the diet at the same time, it is very doubtful how much, if any, of the anti-diarrheal action was due to meta-phenylenediamine *per se*.

This review of the literature indicates the unsatisfactory state of our knowledge regarding the phenylenediamines. In view of their scientific importance and extensive use in certain industries, it is obvious that more definite knowledge of their toxicity and their actions is desirable. The following report deals with a description of the compounds used, their comparative toxicity, and local and systemic effects, together with a brief discussion of the practical application of the results.

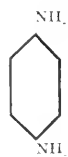
III. Description and Solubility of Compounds Studied

Meta-Phenylenediamine (Lentin).—The structural formula for this compound is



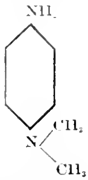
It is a pinkish crystalline solid with a melting point of 83° C.; it is almost tasteless and odorless, and gives from a deep reddish to a brownish color with sodium nitrite, and a yellowish color with ferric chloride.

Para-Phenylenediamine.—The structural formula of this compound is



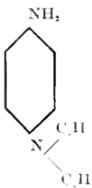
It is a dark brown, or nearly black, crystalline solid with a melting point of 140° C.; it possesses a slight burning taste and odor. With sodium nitrite it gives a wine-red color, and with ferric chloride first a yellowish, then a greenish to a brownish-black color.

Dimethyl-Para-Phenylenediamine.—The structural formula for this compound is



When freshly prepared it is a nearly colorless or light yellowish liquid with a strong, pungent odor suggestive of garlic, and very irritating. It possesses a burning, disagreeable taste. The melting point of fresh crystals is 40° C.; the boiling point of the liquid is 262° C. After standing for a few hours, it becomes black and tarry, and gradually deposits black crystals. It gives a dark greenish (nearly black) color with sodium nitrite, and a reddish color with ferric chloride. In the presence of ferric chloride and hydrogen sulphide it forms methylene blue.

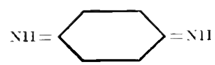
Diethyl - Para - Phenylenediamine.—The structural formula of this compound is



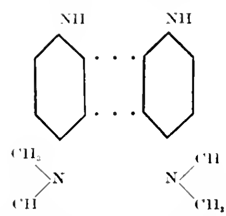
It is very unstable at ordinary room temperature, but more stable when dissolved in benzene. In this form and in its natural state it is a black, tarry liquid with a pungent odor which is less intense and less disagreeable than that of the dimethyl compound; its boiling point is 260° C. It gives a reddish color with ferric chloride.

The behavior of the different phenylenediamines toward different solvents was ascertained by adding 0.1 gm. or 0.1 c.c. of each compound to 10 c.c. of the solvent. The different compounds behaved in about the same way and may be described together. The bases themselves are only slightly soluble in water, but freely soluble in such lipoid solvents as 95 per cent. alcohol, cottonseed oil, ether, and turpentine. They are practically insoluble (forming precipitates) in gasoline, kerosene, liquid petrolatum, and glycerine. The reaction of the watery solutions is alkaline. When treated with acids (hydrochloric and acetic), all of the bases form salts, which are readily soluble in water and possess an acid reaction. The aqueous solutions of the basic compounds are colored slightly pink to orange-yellow with meta-phenylenediamine, brown with para-phenylenediamine, and purplish-red or violet with the diethyl and dimethyl derivatives of para-phenylenediamine. The addition of acid intensifies and brightens the colors. On the other hand, the lipoid solutions possess a yellowish to brownish-black color.

The color of the aqueous solutions is due to the presence of the oxidation product, quinonediimine, which is formed immediately on exposure of the bases to atmospheric oxygen. The structural formula of the quinonediimine derived from para-phenylenediamine is



that from the dimethyl derivative is said to possess the following formula



It occurs as a dark polymerization product, a corresponding product being also obtained from the diethyl derivative.

The results with the different solvents indicate that the bases, being lipoid soluble, might be readily absorbed from the skin and cause local irritation, while the salts would be practically non-irritant and non-absorbable. This was found to be the case. Furthermore, it is indicated that alcohol and cotton-seed oil might be useful for the removal of these compounds from the skin, in the treatment of irritation, etc. Gasoline, kerosene, petrolatum, and glycerine, on the other hand, would be ineffective.

IV. Pharmacological Actions

1. *Fatal Dosage and Comparative Toxicity*

The minimal fatal doses of the different phenylenediamines were determined for rabbits, white rats, guinea-pigs, cats, and dogs. The compounds were used in the form of bases and salts, with and without solvents, depending upon the method of administration. The hypodermic, intravenous, and gastric administrations were made with aqueous solutions of different strengths. For gastric administrations a stomach tube was used, and the dose was washed down with a little water in order to remove the last traces of the solution. The methods used for studying dermal and vapor toxicities will be described separately. The results that were obtained are presented in Table 1.

Para-Phenylenediamine. — When administered subcutaneously, the minimal fatal dose of para-phenylenediamine for white rats was found to be 0.17 gm., and for rabbits 0.2 gm. per kilo. On the other hand, the fatal dose by stomach for a cat was less than one-half that for rabbits—namely, 0.1 gm. per kilo. The fatal dosage by intravenous administration was found to be rather variable in the few dogs that were used. Further sacrifice of animals in order to determine the fatal dosage by intravenous injection of this and other compounds was deemed unwarranted. The definitely effective dose of para-phenylenediamine administered intravenously was about 0.017 gm. per kilo.

Dimethyl-Para-Phenylenediamine. — The minimal fatal dose by hypodermic administration for white rats was 0.05 gm., for rabbits 0.06 gm., and for guinea-pigs 0.1 gm. per kilo. Gastric administration to rabbits required 0.15 gm. per kilo to cause death, and one cat required only 0.02 gm. per kilo.

These results are in accord with the findings in regard to para-phenylenediamine—namely, that cats are more susceptible to these poisons than are rodents.

Intravenously administered, the minimal fatal dose for dogs was about 0.051 gm. per kilo, the lowest effective dose being about 0.003 gm. per kilo. The results with the different species are variable, but, on the whole, they indicate that para-phenylenediamine is much less toxic (roughly one-third to one-half) than its dimethyl derivative.

Diethyl-Para-Phenylenediamine.—As indicated by the results in Table 1, this compound appears to be of about the same toxicity as para-phenylenediamine, but it is decidedly less toxic than the dimethyl derivative. The minimal fatal dose by hypodermic administration for white rats was 0.1 gm., for rabbits 0.25 gm., and for guinea-pigs 0.2 gm. per kilo. When administered intragastrically to rabbits, the fatal dose was 0.45 gm. per kilo, and in one cat 0.3 gm. per kilo. These results again indicate the greater susceptibility of cats than of rodents to these poisons. Administered intravenously, the mini-

mal fatal dose for dogs was 0.07 gm. per kilo — a larger dose than was required of dimethyl-para-phenylenediamine (0.051 gm. per kilo). The results indicate considerable variability in the response of different species, white rats, on the whole, being the most susceptible, cats and rabbits next in order, and guinea-pigs the least susceptible.

Meta-Phenylenediamine. — The minimal fatal dose for white rats, when administered hypodermically, was 0.08 gm., and for rabbits 0.2 gm. per kilo. According to these results, the meta compound is once again as toxic as the para compound for white rats, and about equally as toxic as the para compound for rabbits. On the other hand, the results with gastric administration indicate that the meta compound is less toxic than the para compound. That is, rabbits required 0.3 gm., and each of two cats also required 0.3 gm. per kilo to cause death. These results agree with those of previous investigators using the same method, and tend to demonstrate that meta-phenylenediamine is less toxic than para-phenylenediamine. When administered intravenously to dogs, the definitely effective dose for the circulation was 0.017 gm. per kilo, the lowest effective dose observed being 0.006 gm. per kilo.

Toxicity from Skin.—This was determined by direct application of definite quantities of the different compounds themselves (in basic form) to the shaved skin of rabbits. Twenty-five square centimeters of skin were used and a single application was made on each animal. After the skin had been shaved, it was washed with water in order to remove the excess of soap, and the application was made to an uninjured area. The animals were fastened to boards until symptoms developed; then they were untied and removed to cages for further observation. Meta-phenylenediamine and para-phenylenediamine were used in dry form and in strong alcoholic solution. The effects of the strongest (10 per cent.) alcoholic solutions were not fatal, consisting only of moderate erythema. These compounds can, therefore, be regarded as practically non-toxic when applied locally, except for the mild dermatitis which they produce. The result might be quite different with repeated applications upon the same area — as, for instance, in chronic intoxication from hair dyes and in the dyeing of furs—or when applied to injured skin. The unlimited possibilities of producing intoxications of this kind were not feasible for testing under the conditions of the investigation.

On the other hand, the dimethyl and diethyl derivatives of para-phenylenediamine were decidedly toxic, causing death from the application of very small quantities in from fifty minutes to three hours. Definite quantities of the compounds measured with a pipette graduated to 0.005 c.c. were spread evenly over 25 sq. cm. of the shaved and uncovered skin in the same way as were the meta and para compounds. The local and systemic effects will be described later. With dimethyl-para-phenylenediamine the minimal fatal dose was 0.0024 c.c., and with diethyl-para-phenylenediamine, 0.005 c.c. per square centimeter per kilo of body-weight, indicating that the diethyl compound is only about half as toxic as the dimethyl compound. Dogs were found to be less suitable for experiments of this sort. The fatal doses of the two compounds for rabbits were applied in the same way on two dogs. Both compounds caused considerable erythema and urticarial rash; in addition, the dimethyl compound caused

marked swelling of the skin. The animal receiving the dimethyl compound (0.84 c.c. on 200 sq. cm. of skin) was found dead the following morning (at the end of twenty hours). Assuming that the skin absorption in man and rabbits is about the same, the fatal dose for an adult of 60 kilos body-weight would be about 3.6 c.c. for 25 sq. cm. of skin area, or the equivalent of about one teaspoonful of dimethyl-para-phenylenediamine on the palm of the hand. With the exception of acetylcholin, there are no other poisons, as far as I know, which, when applied to the unbroken surface of an organ (mucosae and serous surfaces are not referred to here), cause typical symptoms of systemic poisoning like the dimethyl and diethyl derivatives of para-phenylenediamine. In this sense, these phenylenediamines may be regarded as unique and very efficient poisons, since they cause symptoms and even death from application to unbroken skin. Acetylcholin was found by Hunt (33) to cause a fall of blood pressure when applied to more favorable locations—namely, the surfaces of trachea, liver, and skeletal muscles.

TABLE 1.—MINIMAL FATAL DOSES OF SOME PHENYLENEDIAMINES[1]

Animal	Para-Phenylene-diamine	Diethyl-Para-Phenyl-enediamine	Dimethyl-Para-Phenylenediamine	Meta-Phenyl-enediamine
		Subcutaneously		
White rat	0.17 (10)	0.10 (15)	0.05 (14)	0.08 (11)
Rabbit	0.20 (3)	0.25 (12)	0.06 (12)	0.20 (2)
Guinea-pig		0.20 (9)	0.1 (3)	
		Intragastrically		
Rabbit	0.25 (7)	0.45 (6)	0.15 (4)	0.3 (4)
Cat	0.10 (1)	0.30 (1)	0.02 (1)	0.3 (2)
		Intravenously		
Dog	0.017 gm. (3) definitely effective	0.07 (3) just effective= 0.005 per kg.	0.051 (8) just effective= 0.003 per kg.	0.017 (3) definitely effective
		Vapor		
White rat	none	no effects (5)	1:500,000 survived (5)	– –
Guinea-pig	none	no effects (3)	1:7,000,000 1:5,000,000 1:4,200,000 (3)	– –
Rabbit	none	no effects (1)	1:2,000,000 (1)	– –
		From Skin		
Rabbit	none (3)	0.005 c.c. per sq. cm. per kilo (10)	0.0024 c.c. per sq. cm. per kilo (13)	none (3)
Dog	– –	0.004 c.c. per sq. cm. per kilo not fatal (1)	0.004 c.c. per sq. cm. per kilo (1)	– –

[1] Figures outside of parentheses represent grams per kilo; those within parentheses, number of animals used.

Vapor Toxicity.—This is of interest in connection with the industrial uses of phenylenediamines, especially of dimethyl-para-phenylenediamine which is rather volatile. Preliminary trials with the dimethyl and diethyl derivatives of para-phenylenediamine indicated that the saturated vapors of the dimethyl derivative were distinctly toxic, being fatal to white rats under a bell-jar. The vapors of the diethyl derivative produced no symptoms whatever. The para and meta compounds are non-volatile at ordinary room temperature and at 38° C. The quantitative study of vapor toxicity was limited, therefore, to dimethyl-para-phenylenediamine. The method used was practically the same as that used for the study of irritant war "gases" previously described (34).

The animals were placed in a 5-liter, wide-mouthed bottle lying on its side and having an inlet and outlet for the toxic vapors. The inlet was connected by glass and rubber tubing to a bubbler containing the compound and immersed in a water bath at constant temperature. The bubbler, in turn, was joined to a flow-meter through which air was blown by means of an ordinary motor and blower. By varying the temperature around the bubbler and the volume of air passing through it, it was possible to vary the concentration of vapors of the compound. The nominal vapor concentration of the compound to which the animal was exposed was obtained by dividing the loss of weight of the bubbler by the volume of air which passed through it. A verification of the nominal vapor concentration by chemical analysis was not deemed necessary for my purposes. The figures which follow refer to nominal concentrations only.

Considerable variation in the response of different species to the vapors was found, and this is in general agreement with the variations in toxicity observed after gastric and subcutaneous administration of the compound. White rats just survived concentrations of 1:500,000; higher concentrations were fatal. Rabbits required much lower concentrations (1:2,000,000) and guinea-pigs were killed by still lower concentrations (1:7,000,000 to 1:4,200,000). The symptoms consisted of restlessness, dyspnea, convulsions, and death. The animals wiped their nostrils and licked their chops, thus indicating local irritation by the poison, but no increase in salivation or frothy fluid indicative of pulmonary edema was evident. The symptoms presumably occurred as a result of alveolar absorption of the compound itself, and were identical with those from other methods of administration.

Comparative Toxicity.—Owing to the marked variations that were encountered in different species and sometimes in the same species, an accurate comparison, according to the minimal fatal dosage of the different compounds, is difficult. In connection with the discussion of the toxicity of the individual compounds, comparisons were made in this way in a few instances. These comparisons and the results given in Table 1 indicate that dimethyl-para-phenylenediamine is the most toxic of all the compounds studied. This is true when it is administered hypodermically, gastrically, dermally, and through the lungs. It is, roughly speaking, about two to three times as toxic as diethyl-para-phenylenediamine and para-phenylenediamine when administered hypodermically and gastrically. Diethyl-para-phenylenediamine appears to be no more toxic than para-phenylenediamine, and meta-phenylenediamine does not differ markedly in its toxicity from the para compound, being only

slightly less toxic when administered gastrically, and somewhat more toxic for rats when injected hypodermically. None of these compounds produced fatal effects when applied to the skin, and diethyl-para-phenylenediamine was not toxic in vapor form. There is no question, therefore, that dimethyl-para-phenylenediamine is the most toxic of the compounds that were studied. This marked toxicity is due in part to its volatility and lipoid solubility, and in part to the methyl groups which it contains.

Accurate comparisons with the results of previous investigators are impossible because the objects of their experiments were different and their results were also variable. Their experiments were usually aimed at the reproduction of symptoms observed in human individuals from the use of hair dyes or exposure to dyes in the fur industry, and at the reproduction of edema in animals. For instance, the results of Meissner indicate that 0.074 gm. per kilo of para-phenylenediamine was fatal to a cat; that 0.082 gm. per kilo of the diethyl derivative was not fatal. The results of Erdmann and Vahlen are similarly irregular. These authors used from 0.04 to 0.4 gm. per kilo of the para compound to produce edema in rabbits, and it is not recorded whether the administrations were fatal. In dogs, hypodermic administration of 0.022 gm. per kilo caused marked symptoms, intravenous administration of 0.033 gm. per kilo gave no effects, and gastric administration of 0.05 gm. per kilo caused very marked symptoms. Obviously the fatal dosage and limits of toxicity cannot be accurately determined in this way. The results presented in this section give, therefore, a more definite idea of the toxicity of the phenylenediamines than was previously obtainable.

2. *Local Effects*

A study was made of the effects of the different phenylenediamines on the skin of rabbits and on human skin. The skin was previously shaved, washed with soap and water, and dried. The compounds were then applied directly to the uninjured areas of about 25 sq. cm. of rabbit's skin, and of 1 to 5 sq. cm. of human skin. The skins were left uncovered. The animals were tied to boards for varying periods of time during the observation of the acute effects, and were observed daily thereafter in their cages until the lesions disappeared. When symptoms of systemic toxicity appeared, the animals were untied and replaced in their cages.

The application of meta-phenylenediamine and para-phenylenediamine in dry basic form rubbed into the skin had no effect. Ten per cent. alcoholic solutions of these compounds produced only a mild erythema on rabbit's skin, and a slight burning and itching sensation on human skin. In some individuals no effects whatsoever could be demonstrated. Different results might be obtained with continued applications over long periods of time, as in chronic poisoning, or with applications on injured skin. Sand-papered areas or injuries on rabbit's skin from shaving responded with more redness and more pronounced urticaria, but no blisters, nor lasting effects were produced. There were also no demonstrable symptoms of systemic toxicity with the meta and para compounds when applied in this way. It was concluded, therefore, that these compounds are relatively non-toxic and non-irritant for rabbit's skin. This is

probably also true for human skin, as far as acute dermatitis and toxicity are concerned. There were no prospects of securing adequate material for proper study of chronic poisoning, however, and further study with these compounds was, therefore, abandoned.

On the other hand, the dimethyl and diethyl derivatives of para-phenylenediamine were found to be very irritating and toxic when applied to healthy skin. The effects of these two compounds differed quantitatively, but were the same qualitatively. They may, therefore, be described together.

Rabbit's Skin.—Dimethyl-para-phenylenediamine in different quantities, ranging from 0.0001 c.c. to 0.0062 c.c. per square centimeter of skin per kilo of body-weight, was applied to the skins of twelve rabbits, and diethyl-para-phenylenediamine in quantities ranging from 0.0018 c.c. to 0.006 c.c. per square centimeter of skin per kilo was applied to the skins of ten rabbits. The results were uniform throughout, being more pronounced with the higher than with the smaller quantities. The following protocol will give some idea of the results that were obtained.

Protocol.—Rabbit. 2.3 kg.

Before Experiment. — Respiration, 60; pulse, 200; temperature, 39° C.

2:10.—0.2 c.c. of dimethyl-para-phenylenediamine applied to 25 sq. cm. of skin.

2:15.—Struggling.

2:18.—Beginning wheal formation; skin raised. Occasionally struggling.

2:25.—Marked tremor followed by convulsions, chiefly in the extremities; pupils dilated. Respiration, 246; pulse, 228. Mucosae, cyanotic; tongue, blue.

2:33.—Marked, continuous bilateral convulsions throughout the body; cyanosis; pupils dilated; loud wheezing. Marked wheal covering entire area of application. Respiration, 198.

2:40.—Marked frothing of saliva; pupils widely dilated; wheezing; convulsions. Pulse full and slow, 120; temperature, 39.8° C.

3:14.—Animal lying on side; died while pulse was being taken. Pulse, 180; temperature, 38.5° C. Respiration stopped before heart. Marked cyanosis; pupils dilated.

Autopsy. — The only important changes noted were: discoloration of the skin at the site of application of poison; underlying tissue very gelatinous; some discoloration of fascia and muscle underneath. The blood was very dark, with a tinge of brown. Spectroscopic examination showed the presence of reducible oxyhemoglobin by ammonium sulphide ($(NH_4)_2S$). Marked cyanosis of all viscera.

Both compounds caused marked discoloration of the skin and underlying tissues, the areas appearing from a light blue to black according to the quantity of the compound used. In from fifteen to thirty minutes there was considerable rash and wheal formation with spreading swelling, the painted area being sharply raised above the surrounding skin. At the end of two to three hours, the entire area to which the compounds were applied was uniformly swollen, prominent, pouchy, and soft, rising to a height of 2 to 3 cm. The swellings were movable and appeared to be limited to the skin. There was no coagulation or erosion of tissue. The local swellings persisted for variable lengths of time in different animals, and did not seem to be altogether dependent upon the dosage, although the larger quantities tended to produce more pronounced and more lasting swellings. As the highest doses killed the animals, the relation of the dosage to the degree of effect was difficult to establish. With some animals the lesions remained several weeks (from four to six); with others, from twelve to fourteen days. As a rule, the skins healed completely, leaving only a dried, dark area at the site of application, and this eventually desquamated. There were no infections and suppurations.

The systemic symptoms which accom-

panied the local effects were rather marked. After the initial symptoms of local irritation, the animals remained quiet for about ten to fifteen minutes. Then the respiration and the pulse gradually became accelerated; there were increased reflex excitability, marked struggling, cyanosis, and, finally, convulsions of the medullary and spinal types. With the smaller doses of the dimethyl derivative (about 0.001 c.c. per square centimeter per kilo) increased reflex excitability and only one or two convulsions occurred, but with the higher doses (0.005 to 0.006 c.c. per square centimeter per kilo) the convulsions were continuous, and death occurred in from fifty minutes to two hours after the application of the agent. These symptoms were similar to those following hypodermic administration of both derivatives, and were due to the agents themselves. At autopsy the only important changes observed consisted of marked cyanosis of all viscera; rather pronounced intestinal peristalsis, and a marked discoloration at the site of application, extending through the subcutaneous fat to the aponeurosis of the recti muscles. The skin at the site of application was markedly edematous, being very gelatinous, soft, and macerated. As a rule there was very little surface extension of the dark discoloration beyond the area of application. The blood of some animals appeared brownish, and that of others was very dark. Definite proof of the existence of methemoglobin by the usual spectroscopic tests was not obtained, however. The dark color of the blood was complicated by the presence of the compounds themselves, which become nearly black on contact with tissues. It was difficult, therefore, to ascertain how much of the dark color of the cyanotic blood was the result of ordinary asphyxia, and how much was due to the compound. In dogs injected with these compounds and receiving artificial respiration, the blood also remained very dark.

Human Skin.—The effects of dimethyl-para-phenylenediamine and diethyl-para-phenylenediamine were observed on six subjects. The quantities of the dimethyl derivative used ranged from 0.001 c.c. to 0.005 c.c. per square centimeter of skin; the quantities of the diethyl derivative, from 0.005 c.c. to 0.02 c.c. The effects were more pronounced with the larger quantities.

The effects following the application of dimethyl-para-phenylenediamine consisted of local heat, tenderness, erythema, maculopapular rash with quantities of 0.001 c.c., and blisters with the larger quantities. The effects appeared in from fifteen to thirty minutes, and spread to about six times the original area of application. Itching at this time was rather marked. On the second or third day there were hemorrhages and changes in blood pigment in the deeper layers of the skin. From the third day on, the lesions were quiescent and seemed to be healing; they appeared completely healed about the eighth day. On the eighth day, however, three subjects experienced marked itching, and gradually there appeared wheals with considerable erythema in the same areas to which the compounds had been originally applied. These symptoms persisted for about two weeks, and then gradually disappeared without causing further annoyance.

The same six subjects responded with temporary local heat and marked itching and two of them showed also a papular rash after the application of about five times the quantity of diethyl-para-phenylenediamine. These effects indicate that the diethyl derivative is less

irritating than the dimethyl derivative. There were no blisters and no late effects, all signs and symptoms of irritation being absent on the following day.

The application to human skin of both the dimethyl and diethyl derivatives in the form of salts (hydrochlorides) in solution produced no effects at all. In this form the compounds are not lipoid soluble, and are therefore not absorbed from the skin.

The effects on the skin caused by these compounds in vapor form are practically negligible. The jacketed test-tube method of Lynch, Smith and Marshall was used in these experiments. Exposures of skin to saturated vapors of dimethyl-para-phenylenediamine for thirty minutes caused only small papules in two subjects, and no effects in three other subjects. Application of dimethyl-para-phenylenediamine in the same way for thirty minutes produced no effects on five subjects.

Prevention and Treatment of Skin Lesions.—The influence of various lipoid solvents on the irritant properties of dimethyl-para-phenylenediamine was tested, with the idea of using the most suitable solvent in the prophylactic treatment of workers with this compound. Five per cent. concentrations of the dimethyl derivative in cotton-seed oil, in 98 per cent. alcohol, in turpentine, and in 5 per cent. castile soap were made and applied directly to areas 2 cm. in diameter on the skins of forearms of the same subjects used in the experiments described above. As a control, 0.002 c.c. of the compound itself was applied to each forearm. The control and soap solution produced the usual effects consisting of burning, tenderness, erythema, discoloration, and blisters, while the oil, alcoholic, and turpentine solutions produced no demonstrable effects for three days after application, and the subjects were dismissed. Two subjects reappeared on the eighth day, however, and two on the thirteenth day after application, with the usual signs and symptoms of dermatitis, including blisters in the areas where the alcohol, oil, and turpentine solutions had been applied. Meantime, the control and soap areas had practically healed. The development of latent dermatitis is not peculiar to these compounds, but was observed also with mustard gas and other irritants during the late war.

Similar results were obtained on a dog whose shaved skin was painted in several places with the same solutions and control that were used on the human subjects. The control and soap areas showed the presence of erythema and urticaria before the areas that were painted with alcohol, turpentine, and oil solutions. In other words, soap, as compared with other solvents, facilitated the production of dermatitis presumably because of the increased lipoid solubility of the irritant or emulsification of skin lipoids with it. It would, therefore, be useless as a detergent for the removal of dimethyl-para-phenylenediamine under industrial conditions.

The results obtained show that soap and the lipoid solvents that were tried do not interfere with the development of dermatitis from dimethyl-para-phenylenediamine. Rubbing the skin with these solvents was also tried, but was found to be ineffective for complete prevention of the dermatitis after itching once started. The most efficient solvent for removal of the irritant was found to be acetic acid which can be used in high concentrations (up to 50 per cent.), and which converts it into a soluble acetate. This is the choice solvent for industrial purposes. After itching has definitely begun, however, acetic acid is

also without influence on the urticaria and vesication which usually follow.

The pruritus after the application of dimethyl-para-phenylenediamine, or after the handling of articles containing it, was rather marked. The following alleged antipruritic agents were, therefore, applied locally and in liberal quantities: 25 per cent. magnesium sulphate; 2 per cent. ammonia; 10 per cent. benzyl alcohol in lard; and benzyl alcohol, full strength. All of these measures gave temporary relief, that is, immediately after application and for about five minutes, but after that itching continued as usual. Plunging or bathing the parts in cold water gave as good relief as any of the preceding measures

Variability of Human Skin.—The response of different human skins to these compounds differed. Under the conditions, it was impossible to ascertain the extent of the variability, but a few preliminary trials were made, using the method of Marshall, Lynch, and Smith (35). That is, a series of different concentrations of the compounds were made in petrolatum liquidum and were applied to areas of about 1 cm. in diameter on the forearms of six subjects. The concentrations of the dimethyl derivative used ranged from 0.01 per cent. to 5 per cent. The lowest effective concentration, as indicated by redness and local heat in three subjects, was 0.1 per cent., and in three others it was 1 per cent. Another subject, a worker with this compound, was found to respond invariably to a 0.01 per cent. concentration. The concentrations of the diethyl derivative ranged from 0.1 per cent. to 10 per cent. The lowest effective concentration in one subject was 0.2 per cent., and the remaining five subjects failed to give responses with the strongest (10 per cent.) solution used. It is obvious, therefore, that there is considerable variation in the response of different human skins to the dimethyl and diethyl derivatives, when they are dissolved in petrolatum liquidum. The study could not be pursued further for the lack of subjects.

Antagonism to Dichlorethylsulphide.—The dimethyl and diethyl derivatives of para-phenylenediamine possess certain properties which might make them useful as preventives or adjuvants in the treatment of burns from dichlorethylsulphide (mustard gas). That is, they are lipoid soluble bases and penetrate the skin readily, and they also react readily with acids forming salts which are non-irritant as far as skin is concerned. Assuming that the mechanism of the action of dichlorethylsulphide as explained by Lynch, Smith, and Marshall (36) is correct and consists of an intracellular acidosis, due to the liberation of hydrochloric acid, the direct application of a base like dimethyl-para-phenylenediamine should mitigate the local irritant action of the dichlorethylsulphide to some extent at least. The chief disadvantage with dimethyl-para-phenylenediamine is its systemic toxicity from rapid skin absorption. Nevertheless, several attempts were made to treat mustard gas burns produced on the shaved skins of rabbits. The dimethyl-para-phenylenediamine was applied directly to the areas treated with mustard gas. The results were disappointing. Small quantities of dimethyl-para-phenylenediamine were ineffective, and large quantities (0.002 c.c. and over per square centimeter of skin per kilo body-weight) killed the animals. In some animals there appeared to be some retardation in the development of burns, in comparison with the controls, but in the end the ef-

fects of dichlorethylsulphide prevailed. Although these results are negative, they may be of interest to those working with toxic war compounds, since it may be possible to modify the toxicity of certain phenylenediamines and yet preserve their lipoid solubility and render them suitable for treating lesions caused by dichlorethylsulphide and similar compounds.

Blood.—Direct inspection of the skin, after the application of both dimethyl-para-phenylenediamine, and diethyl-para-phenylenediamine, indicated that irritation took place independently of precipitation in the tissues. It is difficult, however, to recognize moderate protein precipitation in this way, and the compounds were therefore added directly to diluted blood and serum. It was found that 1 per cent. concentrations of the bases in 0.9 per cent. sodium chloride solution did not precipitate 10 per cent. dog's blood and serum (also in 0.9 per cent. sodium chloride). There was also no hemolysis, but all mixtures were darker than control dilutions of untreated blood and serum. The presence of methemoglobin in these mixtures could not be established spectroscopically. The hydrochlorides of all phenylenediamines are acid in reaction, possess an astringent taste, and precipitate serum. This is due to the acidity.

3. *Symptoms and Production of Edema and Effusions*

The symptoms produced by hypodermic and gastric administrations of the phenylenediamines are quite similar as far as changes in respiration, pulse rate, body temperature, reflex excitability, and convulsions are concerned. The various compounds differ sufficiently in the production of edemas and effusions to require brief descriptive summaries of their actions. The effects were studied on several different species. The pulse and respiratory rates and rectal temperature were obtained in the usual way.

Meta-Phenylenediamine.—This compound was administered in the form of hydrochloride to six rabbits, ten white rats, one dog, and one cat. The dosage for rabbits ranged from 0.1 gm. to 0.4 gm. per kilo; for rats, from 0.06 gm. to 0.4 gm.; for the dog it was 0.2 gm.; and for the cat, 0.4 gm. The effects of hypodermic and gastric administrations were the same and have been grouped together. The onset of symptoms with gastric administration was slower, however, as would be expected. There was invariably an increase in pulse and respiratory rates and a slight increase in rectal temperature (0.1 to 0.5° C.). With fatal doses, the animals showed tremors, increased excitability, convulsions of medullary and spinal types, marked depression, cyanosis, collapse, and death. Only two rabbits and one rat recovered. The remaining animals died at varying intervals, but as a rule the effects were fatal not later than the day following the administration of the compound. No edemas of the face, conjunctiva, neck, or tongue were observed in any of the animals. At autopsy, the most characteristic change that was found was hydrothorax, but it was also variable. Hydrothorax was definitely present in three rabbits that received 0.2 gm. of the compound per kilo, and absent in two rabbits that received 0.1 gm. and one rabbit that received 0.2 gm. per kilo. It was also present in the cat which received 0.4 gm., but absent in the dog which received 0.2 gm. per kilo. The hydrothorax was always bilateral, and the volume of fluid in the rabbits and in the

cat ranged from 2 to 5 c.c. per pleura, or a total of 4 to 10 c.c. from both pleural cavities. The fluid was clear and colorless. No examination was made for the presence of formed elements. Negative chemical tests with sodium nitrite indicated the absence of meta-phenylenediamine. The abdominal viscera of those animals which showed no hydrothorax appeared rather wet and shiny, but it was impossible to measure the fluid in order to gain a definite idea of the change in fluid volume in the peritoneal cavity as compared with the normal, which is usually too small in volume to be measured. There may have been hydroperitoneum, but it certainly could not be as clearly demonstrated as the hydrothorax.

Other changes at autopsy consisted of marked visceral congestion and edema of one or both lungs in some, but not all, animals. Fresh autopsies indicated unusually active peristalsis of the intestines and contraction of the bladder. In the ten white rats that were studied, hydrothorax, hydroperitoneum, and facial edema were not demonstrable. As far as facial edema is concerned, my results agree with those of Meissner (25), but disagree with the positive result of Hess and Müller (26) in the one rat which they observed. As for hydrothorax, and possibly hydroperitoneum, in rabbits, my results agree with those of Hess and Müller.

Para-Phenylenediamine.—This compound was administered in the form of base and hydrochloride to ten rabbits, ten white rats, and one cat. The range of dosage for rabbits was from 0.1 gm. to 0.45 gm. per kilo; for white rats, from 0.075 gm. to 1.0 gm. per kilo; and for the cat 0.1 gm. per kilo, administered by stomach and subcutaneously. The symptoms by both methods of administration were the same, the time of onset and progress being more rapid with hypodermic administration. All animals showed an increase in pulse and respiratory rates, and the cat and rabbits showed a fall of temperature about fifteen to thirty minutes after administration. With non-fatal doses the respiration became very rapid, dyspneic, and accompanied by loud wheezing which was audible at a distance of 30 feet with some animals. At the same time there was an increase in secretions from the mouth, nose, and eyes. At the end of one and one-half to four hours swelling of the nose, lips, tongue, orbital tissues, conjunctiva, and neck was observed. Facial, tongue, and neck edemas were observed in four rabbits receiving from 0.2 gm. to 0.22 gm. per kilo by stomach and subcutaneously. Edemas were absent in six rabbits receiving from 0.1 gm. to 0.45 gm. per kilo by stomach and subcutaneously. With the higher doses, death supervened before the edema could develop. Figure 1 illustrates edema of the face, tongue, and nose in a rabbit after the administration of para-phenylenediamine hydrochloride.

The facial and neck edemas were characterized by rather pronounced, pouchy and soft swelling. The lips were very thick and the skin of the neck was pendant. The tongue was so swollen that it protruded from the mouth. Erdmann and Vahlen attributed the marked dyspnea to obstruction in the pharynx and glottis by the swollen tongue. The orbital tissues and conjunctiva were so swollen that they gave the appearance of exophthalmos. When the effects occurred, they were indeed very striking and unmistakable, but some rabbits showed no demonstrable edemas or ef-

fusions anywhere. At autopsy, the rabbits which showed facial and cervical edemas showed no hydrothorax nor hydroperitoneum. The ten white rats which were injected with doses ranging from 0.075 gm. to 1 gm. per kilo showed no edemas nor exudations anywhere. All the rabbits which showed edemas of the face and neck died eventually, although recoveries from the acute edema and other symptoms occurred. The edemas were most pronounced on the day following administration, less pronounced on the third day, and complete recovery took place by the end of the sixth day. One animal died on the sixth, one on the eighth, and one on the thirteenth day after administration. Apparently there was permanent injury to important functions and organs even in those animals which recovered from the acute effects.

The results that were obtained with para-phenylenediamine administered to rabbits and a cat are confirmative of those obtained by previous investigators. The results of previous investigators show that dogs give practically the same response as cats and rabbits. Reports in the literature give the impression that rabbits respond uniformly to the production of edema. The results here reported do not sustain this belief, however, and white rats failed to show evidences of edema. It is concluded, nevertheless, that a certain proportion of rabbits responds to the administration of para-phenylenediamine with a peculiar and marked edema of the face, tongue, conjunctiva, and neck. On the other hand, a certain proportion of rabbits responds quite differently to meta-phenylenediamine — namely, with hydrothorax, and possibly with hydroperitoneum. The production of marked pulmonary edema does not seem to be a prominent feature in the actions of these compounds. Moderate degrees of pulmonary edema could not be detected under the conditions of the experiments.

Dimethyl-Para-Phenylenediamine and Diethyl - Para - Phenylenediamine. — These two compounds gave practically identical results as far as symptoms were concerned; the diethyl compound, however, being less toxic, required larger dosage than the dimethyl compound. Dimethyl - para - phenylenediamine was administered by stomach and hypodermically to four rabbits, two guinea-pigs, one cat, and fourteen white rats. For rabbits the range of dosage was from 0.06 gm. to 0.3 gm. per kilo; for guinea-pigs, from 0.03 to 0.6 gm.; for the cat, 0.02 gm.; and for the rats, from 0.063 to 0.3 gm. Diethyl-para-phenylenediamine was administered in the same way to six rabbits, three guinea-pigs, two cats, and fifteen white rats. The range of dosage was from 0.05 gm. to 0.4 gm. per kilo for the rabbits; 0.03 gm. to 0.2 gm. per kilo for the guinea-pigs; 0.05 gm. and 0.3 gm. per kilo for the two cats, and from 0.013 gm. to 0.3 gm. per kilo for rats.

In rabbits, cats, and guinea-pigs, both compounds caused a prompt increase in respiratory and pulse rates, the increases being somewhat more uniform and pronounced with the dimethyl compound than with the diethyl compound. Rabbits showed a fall in rectal temperature, except when convulsions occurred; then the temperature rose. It fell again, however, when the convulsions stopped. Cats responded more uniformly with a fall in temperature. The rabbits and rats which died as a result of the administration of these compounds showed increased reflex excitability, tremors, convulsions of medullary and spinal types, marked cyanosis, very rapid respiration, marked motor depression, coma, further fall in body temperature.

and death. None of the animals exhibited edemas anywhere. Most of the rabbits and guinea-pigs and all the cats died very soon or eventually after the administration of the compounds. White rats showed a mortality of about 50 per cent., depending on the dosage.

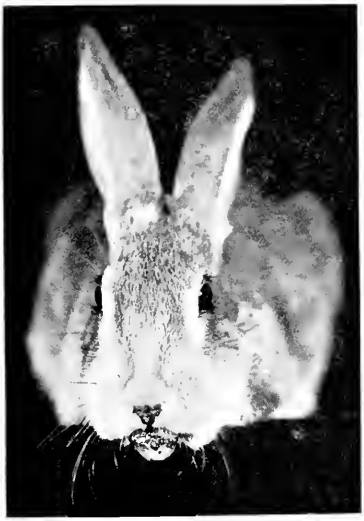


Fig. 1.—Edema of tongue, nose, and face following administration of 0.2 gm. of para-phenylenediamine per kilo by stomach to a rabbit (1.2 kg.). Before administration, the pulse rate was 212, the respiratory rate, 84 per minute. Four hours after administration of the agent the pulse rate was 300, the respiratory rate 60. Other symptoms were: dyspnea, marked exophthalmos, and chemosis, facial edema, nose large, tongue hanging and markedly swollen. The rabbit had recovered completely from the edemas at the end of six days; it died of pneumonia and pulmonary edema at the end of thirteen days.

These animals were also used for the determination of fatal dosage of these compounds as described in the beginning of the paper.

At autopsy, the only noteworthy changes consisted of marked congestion of all viscera, marked intestinal peristalsis, and very dark blood. There were no evidences of hydrothorax or hydroperitoneum.

The results obtained agree with those of Meissner's experiments with dimethyl-para-phenylenediamine on rabbits, but do not support his claim that diethyl-para-phenylenediamine causes facial and cervical edema. The reason that edema does not occur after the administration of dimethyl-para-phenylenediamine is because the compound is markedly toxic and death results before the edema process is fully developed; small quantities, that is, less than toxic amounts, are inadequate for the production of edema. On the other hand, diethyl-para-phenylenediamine is no more toxic than para-phenylenediamine, which produces edema in some rabbits. Other factors, as, for instance, altered concentration of the blood, which may be concerned in the production of edema even before it is grossly recognizable, were not studied.

Mechanism of the Production of Edemas and Effusions.—It was thought more desirable to determine the incidence of the edemas and to obtain some idea of the ordinary pharmacological actions of the phenylenediamines before proceeding to a detailed study of the mechanism of the edemas and effusions. The edemas are undoubtedly among the most interesting features in the actions of these compounds. Certain evidences in the literature indicate that the edemas and effusions caused by these compounds are associated with an increase in permeability of the capillaries. It is not indicated, however, why para-phenylenediamine appears to have a predilection for the head and neck, and meta-phenylenediamine for the pleura and peritoneum. The vascularity of certain parts, and the circulatory stimulant properties of the compounds (to be described) would favor the production of edemas and effusions. I have already indicated that volatility

and lipoid solubility play a definite rôle in the predilection of the dimethyl and diethyl compounds for the skin. The rôle of quinonediimine is not established. Section and degeneration of sympathetic nerves do not prevent the edemas. Other possibilities are deprivation of oxygen in the tissues and local acidosis.

4. *Action on Frogs*

The effects of the phenylenediamines on frogs are different from those on mammals. The meta and para compounds cause gradual depression, with muscular relaxation and paralysis (Meissner; Matsumoto). Previous to the present investigation the dimethyl and diethyl derivatives of para-phenylenediamine had not been studied. Fatal and non-fatal doses of these compounds were therefore injected into the anterior lymph sacs of frogs, and the effects observed. Six frogs were injected with the dimethyl derivative, and four with the diethyl derivative. Both compounds gave the same results. The following protocol of an experiment with the dimethyl derivative indicates the effects, and results of analysis of the depressant action.

Protocol.—Frog. 29 gm.

2:17.—0.03 c.c. of 1 per cent. solution of dimethyl-para-phenylenediamine per gram of weight injected into anterior lymph sac.

2:37.—Marked depression; frog sat and refused to move; no increase in reflex excitability. Animal sank in water; made attempts to swim but did not succeed in reaching the air.

3:10. — Complete muscular relaxation; when put on its back, frog lay in place; no convulsions at any time.

Heart dilated and still beating, although very slowly. Blood was very dark. Sciatic nerve and gastrocnemius muscle responded to electrical and mechanical stimuli. The central nervous system was exposed, and weak faradic stimulus was applied from above downward; there was no response by stimulation of cerebral hemispheres in different regions; prompt muscular responses occurred, however, when the same stimulus was applied to the optic thalamus, optic lobes, medulla, cord, and sciatic plexus. The depression appeared, therefore, to be above the optic thalamus.

The results with the remaining frogs were similar, and agreed with those obtained by Meissner and Matsumoto in their experiments with meta-phenylenediamine and para-phenylenediamine on frogs. Briefly summarized, the effects of these compounds on frogs consist of gradual motor depression, marked discoloration of the blood, circulatory collapse, and death. At autopsy the hearts of those animals which died from the effects of the poisons were markedly dilated and refractory to direct mechanical and electrical stimuli. Convulsions were absent even in those animals which received fatal doses. In fact, there was produced a depression similar to that caused by morphine or narcotics, and later a paralysis of such a degree that the animals were not able to perform purposive movements; the effects corresponded to those following ablation of the hemispheres. It was shown that the different portions of the central nervous system from the optic thalamus to the spinal cord, inclusive, and the peripheral nerve trunk, nerve endings, and skeletal musculature were not paralyzed by the highest doses. It was, therefore, concluded that the depression was central in the hemispheres and resembled that produced by morphine. None of the animals used in these experiments showed increased excitability or convulsions. Apparently the main action on the nervous system in frogs was depressant; the stimulant action, if any, was evanescent. It will be seen later that the smooth muscle of excised organs in frogs is markedly stimulated

by the phenylenediamines. It will also be seen that the terminal depressant action upon the circulation is the same in mammals as in frogs. All these findings indicate that the actions of the phenylenediamines are complex.

5. *Convulsant Action in Mammals*

The results obtained with frogs do not throw any light on the cause of the convulsions which occur in mammals, because the predominant action of the phenylenediamines upon the nervous system of frogs is paralysis. The clonic nature of the convulsions in mammals indicates that these are not due to direct muscular (veratrin-like) stimulation. Two other important possibilities remain: (1) that there is direct and more prolonged stimulation of the central nervous system (cerebrum, medulla, and cord) of mammals than of frogs; (2) that asphyxia occurs from alteration of the blood pigment by the compounds, or gradual circulatory depression. Asphyxia may be ruled out at once, because the administration of artificial respiration to operated and unoperated rabbits, cats, and dogs did not prevent the convulsions. Furthermore, the onset of convulsions was rapid, taking place twenty to thirty minutes after application to the skin of rabbits, and after hypodermic injection in white rats, cats, and rabbits, and almost immediately after the intravenous injection of large doses in dogs and cats. Under these conditions, the convulsions continued for some time (from one to one and one-half hours) and increased in severity before cyanosis was evident, although some difficulty was experienced in interpreting this properly because of the dark discoloration of the blood produced by the compounds themselves. The presence of methemoglobin was not established in any of the bloods of the different species studied. Its presence in the blood of animals dying from the phenylenediamines is denied by Meissner and Erdmann and Vahlen. The discoloration was apparently due to the oxidation product of the phenylenediamines, namely, quinonediimine, which does not *per se* contribute to or cause asphyxia. This leaves direct stimulation of the nervous system by the phenylenediamines themselves as the cause of the convulsions. Both the medullary and spinal types of convulsions were observed and it may be assumed, therefore, that both the medulla and cord are involved in the stimulation.

(To be continued)

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OBSERVATIONS UPON THE EFFECTS OF EXPOSURE TO ARSENIC TRICHLORIDE UPON HEALTH

(Continued)

The Late Sheridan Delépine, M.B., C.M., M.Sc.

Phenomena Observed When Arsenic Trichloride Is Exposed to Air

A. Arsenic trichloride exposed to air dried over sulphuric acid and confined in a bell jar of moderate size evaporated fairly rapidly without undergoing any obvious change, and without causing any cloudiness of the air or producing any perceptible deposit upon glass plates exposed in a chamber; $\frac{1}{4}$ c.c. of the arsenic trichloride had almost entirely disappeared in twenty-four hours. The thin layer remaining in the watch glass did not alter in appearance in the course of five days, but at the end of that time it was syrupy in consistency and on being exposed to ordinary air it became opaque and white. Very few microscopic granules were recognizable on the surface of a glass plate exposed in the chamber. The sulphuric acid contained a large amount of arsenic.

B. Arsenic trichloride exposed to air saturated with water confined in a bell jar of the same size as that used in Experiment A behaved quite differently. The air of the jar became rapidly cloudy, and the glass surfaces exposed to this cloudy air were soon coated with a thin white deposit. Ten minutes later the air was still cloudy and minute dew-like drops had formed upon the marginal part of the watch glass containing the arsenic trichloride, and also upon the surface of the glass plates exposed in the jar as well as upon the sides of the jar itself.

After four hours, changes which have already been described were observed in the arsenic trichloride. The droplets formed among the white deposit on the glass surfaces had increased considerably in size. After twenty-four hours, the arsenic trichloride had increased slightly in bulk. The white deposit on the glass plate examined under the microscope consisted of semi-crystallized granules of small size. In the large clear drops of fluid which had formed at fairly regular intervals among this deposit, there were large transparent crystals, some of which were clearly octahedral. (See Fig. 3.) At the end of five days, the bulk of the fluid contained in the watch glass was about five times that of the arsenic trichloride originally placed in it. An abundant semi-crystalline deposit had formed in this fluid. The water in the dish placed in the jar contained a large amount of arsenic as did also the deposit on the glass plates. Notwithstanding these great differences, it is clear that arsenic trichloride emits gases rich in arsenic whether it is exposed to dry or to moist air. (See also animal experiments 17 and 19.)

Arsenic trichloride, 0.98 gm., contained in a watch glass (the surface of the fluid measuring about 7 cm. square) supported by one arm of a special balance was placed under a bell jar of a capacity of about 20,000 c.c. The air of this jar was partly dried by sulphuric acid. Test plates A, B, and C were supported at various heights in the vessel, which was hermetically closed by a glass plate to which it was luted. (See Fig. 4.)

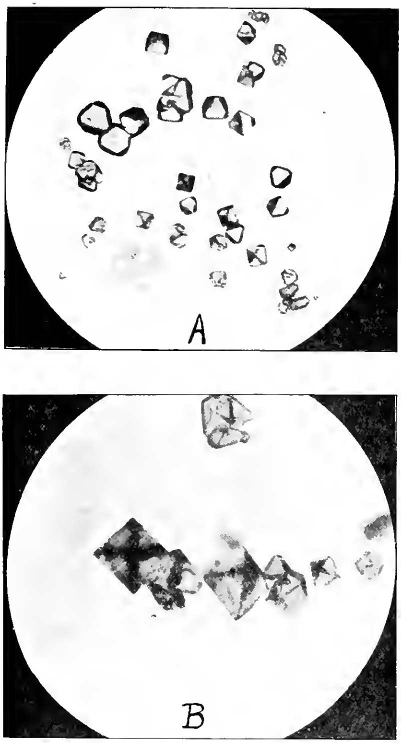

FIG. 3.—Deposit produced by arsenic trichloride in presence of water vapor. (X 175.) A and B=octahedral crystals formed in the droplets of fluid.

During the first hour 0.18 gm. of the arsenic trichloride became gaseous; the fluid in the watch glass lost weight more slowly afterwards, about 0.4 gm. being lost in the twelve hours following the first, and about 0.2 gm. in the subsequent eleven hours. The total loss in twenty-four hours was, therefore, about 0.78 gm., or on an average of 0.0325 gm. per hour. Over one-quarter of the amount lost in twenty-four hours had volatilized during the first hour.

The air of the jar remained clear at first and the arsenic trichloride did not emit any visible fumes, but after several minutes a slight cloudiness was visible in the upper part of the jar and within thirty minutes the whole jar was full of minute particles in active motion, and a white film had formed on each of the test plates A, B, and C. These particles were barely visible to the naked eye, but with the help of a magnifying glass and of a suitable light their motion could be clearly followed. They formed at a short distance above the watch glass containing arsenic trichloride, then rose rapidly to the dome of the jar (*i.e.*, to a height of about 35 cm.). They then dispersed in different directions, forming various streams, and fell down along the sides

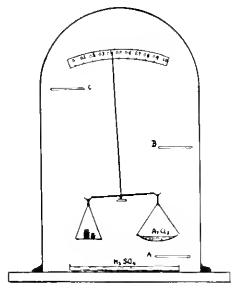

FIG. 4.—Bell jar (22,000 c.c.) showing arrangement adopted for estimating rate of volatilization of arsenic trichloride in air dried by sulphuric acid. A, B, and C=test plates. (Scale 1 to 13.)

of the jar, some of them reaching the bottom. They rose again toward the watch glass, however, and joined the stream of particles arising from the arsenic trichloride. This circulatory motion appeared to be determined by the relative temperature of the air above the watch glass and of that near the walls of the jar. The heat thrown against the sides of the jar by an ordinary incandescent electric lamp, situated at some distance from the jar, was sufficient to divert the stream of particles toward the light. The heat of the hand applied to one side of

the jar had the same effect. The presence of the trace of water remaining in the air appeared to be necessary to the formation of a solid oxychloride of arsenic. The first ascent of the particles was obviously caused by the warming of the air due to the heat of combination. As the warm air over the watch glass rose, it carried with it the light particles as they were formed. On reaching the top of the jar, however, this air was cooled and, being displaced by more warm air, streamed down the side of the jar from which it returned to the neighborhood of the watch glass to replace the rising warm air. At the end of the experiment the upper surface of each of the test plates was covered with a white deposit. This phenomenon is not only interesting from a scientific point of view, but is of importance as indicating a method for the removal of arsenic trichloride fumes.

When ammonia is present in air to which arsenic trichloride is exposed, white fumes are also produced owing to the formation of the chloro-ammonio-arsenical compound or compounds already alluded to. These fumes are composed of solid particles which form denser and more distinct clouds than those of the oxychloride; they are subject to the same movements as those which have been previously described. Advantage was taken of the greater visibility of these fumes to take photographs showing some of the phases of the phenomenon. (Fig. 5.)

A shallow rectangular case was constructed by fixing together sheets of plate glass. Through two small doors at the ends of the base plate, two capsules containing respectively 1 c.c. of arsenic trichloride and 5 c.c. of weak ammonia solution were introduced almost simultaneously. A powerful beam of light was thrown through the glass case and photographs were taken at intervals.

Figure 5A shows the appearance of the glass case immediately after the introduction of the capsules of ammonia (left), and arsenic trichloride (right). The arc lamp was at the right of the case. For the first two or three minutes very little change was observed, then a small cloud formed over the arsenic trichloride and began to rise rapidly to the top of the chamber (about 35 cm.).

Figure 5B was taken five minutes after the beginning of the experiment. The column was deflected toward the light owing to the current of warm air caused by the heat of the lamp (although a trough of water had been interposed to absorb the greater part of the heat). In addition to the main ascending current, a much smaller descending current was noticeable.

Figure 5C was taken ten minutes after the beginning. The fumes, after flowing under the top plate toward its left end, had turned downward along the colder left side of the chamber, and when near the base had flowed along the base toward the right, generally rising before reaching the ascending stream above the capsule of arsenic trichloride. This stream of fumes was composed of subsidiary streams which on expanding produced the clouds visible in the photograph.

Figure 5D was taken fifteen minutes after the beginning. The whole chamber was then full of white fumes, densest on the right over the arsenic trichloride, from which fresh fumes continued to rise.

Figure 5E was taken thirty minutes after the beginning of the experiment, when the fumes had ceased to rise in a continuous stream; a dense cloud hung over the arsenic trichloride, from which fresh fumes burst at intervals. The

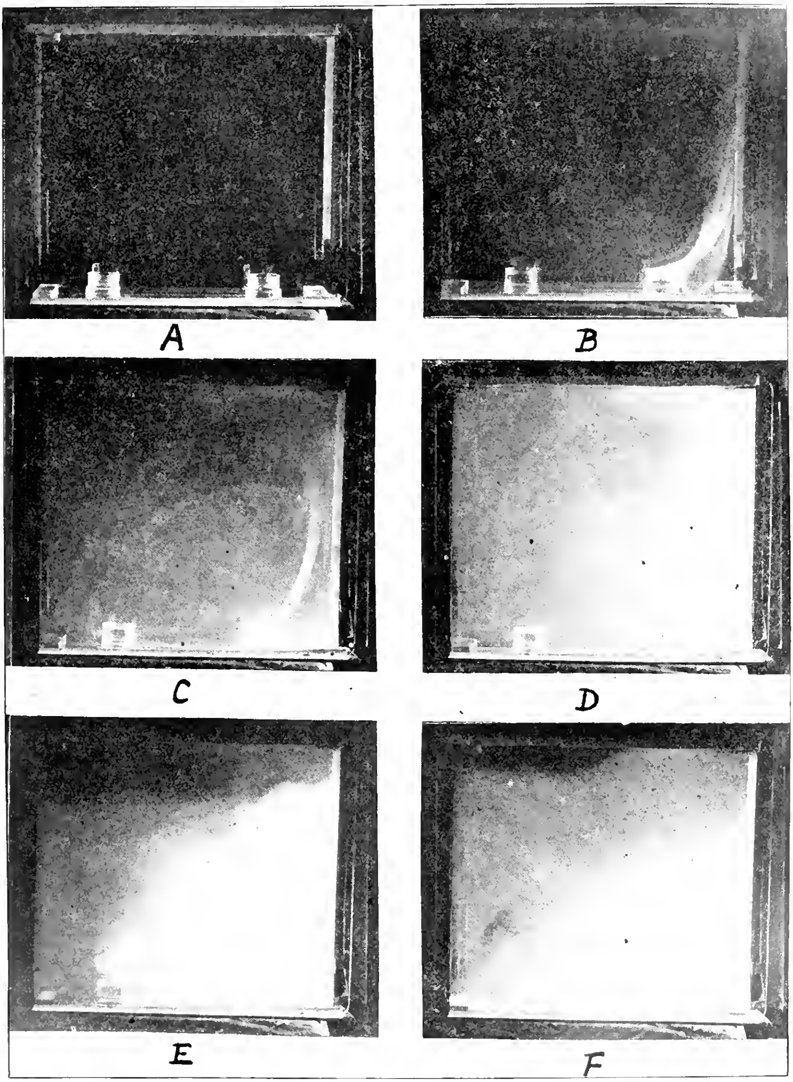

Fig. 5.—Production and distribution of arsenic trichloride fumes. A=beginning of experiment, B=five minutes after beginning, C=ten minutes after, D=fifteen minutes after, E=thirty minutes after, and F=one hour after beginning.

fumes in the upper part of the chamber had begun to settle, falling upon the bottom plate in the form of very fine white granules (semi-crystalline under the microscope).

Figure 5F was taken one hour after the beginning. After a final outburst of fumes, the aerial precipitate had begun to fall so abundantly upon the base plate as to cover it entirely with a white opaque layer which is visible in the photograph. The arsenic trichloride capsule had become visible again and very little, if any, fresh fumes were formed. After two hours more, the precipitate had almost entirely settled; twelve hours later the air of the glass case was quite clear and its appearance was the same as it was before the beginning of the experiment, except that the base plate and the upper surface of objects lying on it were covered with a thick layer of the white deposit already described. Some of the deposit was given to Mr. Heap for analysis, and he found that it differed from the white deposit formed in the presence of air and water alone in that it contained a definite proportion of nitrogen.

At the end of this experiment some arsenic trichloride remained in the capsule and was still capable of emitting fumes. It seemed, therefore, that a state of combination equilibrium had been brought about somewhere about the mouth of the vessel containing arsenic trichloride. Outside this area the air was saturated with ammonia. This view was confirmed by the following experiments:

Two small cups containing respectively 0.5 c.c. of dilute liquor ammoniae and 0.5 c.c. of arsenic trichloride were introduced simultaneously into the lower part of an hermetically sealed jar (24 cm. in diameter and 48 cm. in height). After a few minutes the fumes began to rise above the cup of arsenic trichloride and phenomena similar to those previously described were observed. The cup of ammonia was removed when the whole jar was full of dense white fumes. These had entirely settled three hours later, the bottom plate and test plates being covered with a thick white deposit. The air of the jar was saturated with invisible arsenic trichloride vapors. The cup of arsenic trichloride was then removed and the cup of ammonia returned to its original position. Dense fumes began to rise at once over this cup and after thirteen minutes the whole jar was filled with dense white fumes, which settled down within three hours, leaving the air of the jar quite clear. The jar was now saturated with invisible ammonia vapors. This experiment was repeated several times with the same results. Ultimately the arsenic trichloride cup was closed by a thin solid diaphragm (Fig. 6) fixed to the lips of the cup and suspended at a height of 1 to 2 cm. above the level of the fluid arsenic trichloride. This diaphragm was much convoluted and its shape indicated the intermittence and variations in the intensity of the combination. It had obviously been formed in the plane where the gaseous ammonia and arsenic trichloride had met in suitable combining proportions. Beneath this diaphragm the air was saturated with arsenic trichloride; outside it there was an excess of ammonia.

Moist air containing ammonia was used in these last experiments for the purpose of studying the behavior of arsenic trichloride vapors more closely than was possible when air containing only water vapor came into contact with arsenic trichloride. The object of this study was to find some means of bringing arsenic trichloride fumes under control.

When a current of dry air is caused to pass over the surface of arsenic trichloride, evaporation of the fluid takes place rapidly without alteration in the appearance of the fluid. When the air is moist, the arsenic trichloride becomes rapidly turbid, and after a time a thin layer of clean watery fluid forms on its surface.

FIG. 6.—Solid diaphragm formed in plane of saturation between ammonia and arsenic trichloride vapors. (Normal size.)

The cup is filled with arsenic trichloride vapors generated by a few drops of arsenic trichloride at the bottom of it; the air outside the cup is saturated with ammonia.

When a current of air laden with arsenic trichloride is admitted to a chamber, such as the 215,000 c.c. chamber used in the animal experiments, a cloud is produced near the inlet. This cloud is densest at some distance from the inlet and extends in the direction of the outlet. As it extends, it first rises to the upper part and then gradually falls down in the outlet part of the chamber. The air at the sides of the inlet remains generally clear, or almost clear. The density of the fumes is, therefore, greater in the middle and outlet parts of the chamber than in the inlet part, except near the inlet in the path taken by the fumes. Test plates placed in various parts of the chamber show deposits of various density which indicate the same irregularity of distribution. These observations explain why animals placed in different parts of the chamber are unequally affected by the fumes (see Experiments 11, 12, 13, and 14).

These facts show that arsenic trichloride is very diffusible and enters readily into various combinations when it comes into contact with air containing moisture. The resulting oxychloride is precipitated in the form of fine, snow-like flocculi which are initially so light that the heat generated at the time of combination is sufficient to induce air currents which carry the precipitate to a considerable height, from which it afterwards falls as a kind of snow and covers the upper surface of all the objects exposed to it.

A considerable part of the evaporated arsenic trichloride is disposed of in this way; many of the outlying and apparently heavier particles do not rise with the main stream, however, but fall more or less rapidly to the ground over which they spread gradually. In addition to these visible particles, there is evidence of the presence of invisible vapors of arsenic trichloride when the air is unsaturated with water.

It is obvious that where the amount of air is unlimited there is enough moisture in it to convert the invisible vapors of arsenic trichloride into visible fumes which are not very distinct when the air is nearly dry, but which are very conspicuous when the air is saturated with water. In very dry localities, however, arsenic trichloride might diffuse indefinitely without any visible trace of its presence being noticed, except at places where it came into contact with damp or wet surfaces (such as the mucous membranes of men or animals), or with

moist air, such as expired air.

It is clear that the precipitate of oxychloride and allied products which form in the air have a great tendency to cling to the surface of solid objects with which they come in contact. This is one of the reasons why the hair of persons working in arsenic trichloride plants becomes so rapidly laden with arsenic. Arsenic trichloride is also rapidly absorbed by animal tissues.

Detection of Arsenic Trichloride or Derivatives in the Air of Places Where Arsenic Trichloride Is Prepared or Handled

A previous investigation[2] had shown that the hair of persons and the leaves of plants exposed to arsenical fumes, such as may be generated during the combustion of coal and coke, become loaded with arsenical deposits which can be detected by a suitable method such as the hydrochloric-copper method already described. The hair of persons working in arsenic trichloride plants might, therefore, be expected to give an indication of the extent of their exposure. It appeared desirable to examine the urine also in order to ascertain whether arsenic was absorbed by the lungs, skin and mucous membranes, and excreted by the kidneys.

The results recorded in Table 5 leave no doubt as to the serious extent to which persons working in, or in connection with, arsenic trichloride plants are exposed. Few of the cases investigated show clear evidence of arsenicism, and where such a state was indicated the symptoms were generally slight. The amount of arsenic found in the hair bore a distinct relation to the amount of exposure. The examination of the hair, therefore, supplies valuable information.

Visit to Factory.—The plant inspected consisted of six retorts with condensers housed in a shed open on all sides. The openings through which the retorts were fed were situated on a long upper platform. Four of the retorts were of an old type, the other two were of a new type and there was room on the platform for two more of these new type retorts. Contiguous and parallel to this upper platform, but at a lower level, there was another platform on which arsenic trioxide and chloride of sodium were kept ready for mixing. The retorts and furnaces were situated immediately below the upper platform and from the bottom of each retort there was a conduit taking the residue from the retorts to trucks. On the other side of the retorts, raised slightly above the ground, there was a large tank used for storing arsenic trichloride, and close to this tank there were rows of iron drums filled with arsenic trichloride ready for shipping.

The most striking difference between the old and the new retorts was in their connection with the condensers. From the old retorts the products of distillation rose first through a tall vertical pipe, and were then directed by a horizontal pipe to a lead coil cooled by water contained in a large tank situated at the side of the upper platform. The condensers connected with the new retorts were situated on the upper platform, above the retort, and the pipe bringing the volatile products to the lead coil was entirely surrounded by the condenser. As the products of distillation issued from the condenser they passed through a small separating chamber from which arsenic trichloride and hydrochloric acid issued by sepa-

[2]Arsenic in Modern Life. Jour. Roy. San. Inst., 1902, *23*, 244.

TABLE 5.—RESULTS OF EXAMINATION OF HAIR AND URINE OF PERSONS WORKING IN, OR IN CONNECTION WITH, ARSENIC TRICHLORIDE PLANTS

Date[1]	Chemical Works	Name	Age	Nature of Work	Length of Time Employe.	Arsenic as Arsenic Trichloride in Hair	Arsenic as Arsenic Trichloride in Urine	Chemical Examination of Urine[2] Sp. Gr.	Reaction	Albumin	Indican	Remarks
					months	*mmg. per 100 gm.*	*mmg. per 100 c c*					
Urine												
9 15 17	chemical works, Widnes	H. H.	45	workman in plant	9	264,000	220	1030.0	+3	1?	3	Employed in new plant since end of August or beginning of September; previously in old plant.
Hair												
9 12 17 10 10 17	same "	" " " "	" "	same	10	500,000	80	1031.2	+2	0	1.2	
Urine												
12 26 17	"	" "	"	"	12	6,000	under 10	1026.0	+2	0	3	Taken after the man had been several weeks at Blackpool on holiday.
Hair												
12 31 17	"											
Urine												
9 15 17	"	W. G.	35	"	9	378,000	250	1027.0	+3	1?	–	Employed in new plant since end of August or beginning of September; previously in old plant.
Hair												
9 12 17 10 22 17	"	" "	36	"	10	600,000	80	1022.0	+3	0	1?	
Urine												
12 26 17	"	" "	"	"	12	25,000	under 10	1028.0	+2	1?	2	Taken after the man had been several weeks at Blackpool.
Hair												
12 31 17												
1 17 18	"	J. M.	—	"	12(?)	300,000	30	1018.0	+2	0	0?	Dermatitis—arsenical.
1 17 18	"	S. L.	—	"	12(?)	240,000	5	1017.0	+2	0	0?	R and necrosis.
1 15 18	"	–. H.	—	chemist[3]	12(?)	280,000			—	—	—	
10 8 17	laboratory of chemist	P. K.	30	"	18	80,000	10	1016.0	+2	—	1	
11 23 17	inspection department	" "	"	"	19½	60,000	10	1016.0	+1	0?	0	Has not been well.
1 29 18	same	" "	"	"	21½	8,000	10	1022.0	+1	0	1?	About six weeks after short holiday.
10 8 17	"	J. S. J.	20	"	2	70,000		1015.0	+2		1	
11 23 17	"	" " "	"	"	3½	45,000	10	1031.0	+3	1?	0?	
1 29 18	"	" " "	"	"	5½	10,000	25	1028.0	—	1?	1	
11 27 17	chemical works, Gateshead	J. A.	28	workman in plant	3	22,500	under 10	1023.0	+2	1?	1?	
11 27 17	same	J. B.	33	same	3	75,000	" 10	1013.0	+2	0	0?	

[1] Arrangement of dates follows the American custom—*i.e.*, month, day of month, year.

[2] 1=slight or scant; 2=moderate; 3=strong or abundant. A material amount of arsenic was found in the urine only in the cases of the workmen H. H. and W. G., and was associated with marked excess of indican on three occasions.

[3] The chemists were exposed to the fumes of arsenic trichloride in connection with the sampling and the analysis of the product. Mr. H. was in addition exposed to fumes from the retorts while supervising the workmen.

rate pipes. The hydrochloric acid was conveyed away by a drain, and the arsenic trichloride was carried down a pipe to a collecting pipe which emptied into a large tank. A tap near the bottom of this tank was used to fill the iron barrels.

The salt and the arsenic trioxide were mixed by men on the mixing platform just before being shovelled into the retorts. The lid of the charging hole of the retort was unsealed just before this operation, and the fumes from the retort and the dust from the chemicals were carried down into the retorts by an induced downward draft. To protect themselves against dust, the men wore handkerchiefs over the mouth and nose. Gas helmets were also available.

At the time of this visit, three of the retorts were working—one of the old type (retort 4) and the two new type retorts (5 and 6). From these three retorts a considerable amount of irritating fumes escaped at various places. This was most noticeable in the neighborhood of the pipe rising from retort 4. It appeared also that escape was taking place through the sulphuric acid seals guarding a lateral valve and, in all probability, some escaped also from the drain carrying away the waste hydrochloric acid. A strong odor was also noticeable in the neighborhood of the storing tank, and more particularly near the outlet tap. Although there was a fairly strong wind at the time of the visit, a very distinct odor, which resembled that of hydrochloric acid but differed materially from it, was noticeable in every part of the installation. This odor was strongest on the upper platform near the retorts, particularly near the old retort.

Three pairs of test plates were exposed as follows: two plates at the level of the ground at a distance of about 2 feet from one side of the vertical pipe going to the condenser from retort 4, and about 3 feet away from the charging hole of the retort; two plates in a corresponding position near retort 5, but at a height of 19 inches; and two plates near retort 6, in a similar position, but at a height of 9 inches.

These plates were left from 2 P. M. on December 19, 1917, until the same hour on December 20. They were then replaced by three similar sets of plates which were left exposed in the same way for 24 hours and taken up on December 21. During each of the exposures the retorts were charged once. At the end of the exposure, each pair of plates was carefully packed and forwarded to the laboratory.

On arrival at the laboratory these plates presented a very striking appearance. The two sets of plates which had been exposed near retort 4 were thickly encrusted with a sulphur-yellow, saline-looking deposit, which could be scraped off with difficulty. When water was added the yellow color diminished or disappeared for a short time, and then gradually reappeared. On the addition of potash the color deepened and became brownish, and after an interval a brownish-red precipitate separated. (The color was apparently due to the presence of some iron chloride.)

The deposit on the plates exposed near retort 6 was much less abundant than that on the plates near retort 4, and was not so yellow. The plates near retort 5 also had a very distinct deposit, but this was much less abundant than that on the plates exposed near retort 6. All these deposits were dissolved in a dilute potash solution and the amount

of arsenic was estimated both by the iodine method and the hydrochloric-copper method with the results shown in Table 6.

The differences between the results obtained are puzzling, and are probably due to the fact that it was found difficult

TABLE 6.—TOTAL ARSENIC (AS ARSENIC TRIOXIDE) DEPOSITED ON PLATES 138 MM. IN DIAMETER

A. Estimated by Iodine Method

Position of Plates	Twenty-Four-Hour Exposure, Dec. 19-20	Twenty-Four-Hour Exposure, Dec. 20-21
	mmg.	*mmg.*
Near retort 4, at level of floor	341,000	39,600
Near retort 5, 19 inches high	6,930	4,950
Near retort 6, 9 inches high	5,940	17,820
B. Estimated by Hydrochloric-Copper Method		
Near retort 4, at level of floor	200,000	180,000
Near retort 5, 19 inches high	8,300	4,000
Near retort 6, 9 inches high	16,000	50,000

to obtain clear solutions. Filtration was obviously contraindicated. It is probable also that something interfered with the action of the iodine. The solutions were thoroughly shaken to equalize the distribution of any undissolved parts, but this obviously was insufficient. Two points are clear, however—namely, that a material amount of arsenic could be obtained from the air in the neighborhood of each of the retorts, and that the air near the old retort was laden to a much greater extent than that near the new retorts.

Protection of Workmen against Arsenic Trichloride Fumes

When about 1 gm. of arsenic trichloride, with a surface of approximately 7 cm. square, is allowed to evaporate in 20,000 c.c. of still, moderately dry air, about 0.18 gm. of the fluid is volatilized during the first hour, and 0.4 gm. during the following twelve hours. Broadly speaking, about half of the arsenic trichloride is volatilized during the first twelve hours.

If the precipitate which forms in the air charged with this vapor is collected on test plates, the distribution of the fumes can be ascertained. In one experiment 0.25 c.c. of arsenic trichloride was allowed to evaporate in the comparatively dry still air of the 215,000 c.c. chamber. The fluid was placed at a height of 20 cm. above the floor of the chamber. One test plate was placed at a height of 20 cm. vertically above, and another 20 cm. below the arsenic trichloride. A third plate was placed at a distance of 50 cm. from plate 1 and at the same level; plate 4 was placed at the same distance from plate 2 and at the same level. At the end of six and three-quarters hours all the test plates were removed. The appearance of these plates and the amount of arsenic recovered from each of them are indicated in Table 7.

After the four test plates had been removed, a fifth test plate was fixed in the chamber in the same position as that occupied previously by plate 1. The chamber was closed again, and opened only after an interval of four days. At the end of that time there had formed on the plate a thin crystalline deposit which also contained arsenic. The amount and distribution of the deposit is very much affected by driving air laden with arsenic trichloride through suitable channels, as is shown by the following experiments for which the chamber used in the previous experiment was employed.

The fumes were carried into the chamber by a current of air which had been passed over arsenic trichloride.

This current was admitted at one end of the chamber by a tube having a sectional area of about 1 cm. square. An equal amount of air was removed from the other end of the chamber by a tube of the same diameter. Test plates were placed: (1) about 10 cm. below the inlet pipe; and (2) about 30 cm. vertically above the inlet pipe. After 10,600 c.c. of air had passed through the chamber in the course of sixty-five minutes, it was found that 0.42 gm. of arsenic trichloride had been taken up by the 10,600 c.c. of air. Both test plates were covered with a dense white deposit, particularly plate 1. The amount of arsenic recovered from plate 2 was 544 mmg.

TABLE 7.—RESULT OF EXPOSURE OF PLATES IN ATMOSPHERE CHARGED WITH ARSENIC TRICHLORIDE FUMES

Plate No.	Position in Relation to Arsenic Trichloride	Appearance of Deposit		Arsenic as Arsenic Trioxide Recovered from Each Plate
		By Reflected Light	By Transmitted Light under Microscope	
				mmg.
1	20 cm. vertically above	opaque white, dense	semi-crystalline granules, very abundant and large	6,400
2	20 cm. vertically below	grayish white, less dense	semi-crystalline granules, less abundant than on plate 1	3,200
3	20 cm. above and 50 cm. to one side	whitish gray	smaller and less abundant than on plate 2	2,400
4	20 cm. below and 50 cm. to one side	whitish gray	same as plate 3	2,400

The inlet pipe which was turned upward was now partly covered with a ventilating hood formed by a glass cylinder 3 cm. in diameter connected by four tubes with the outlet tube, so that the air charged with arsenic trichloride was thrown into the hood-like cylinder instead of being admitted freely into the chamber. In every other respect the experiment was conducted exactly in the same way as the previous one—*i.e.*, 10,600 c.c. of air charged with arsenic trichloride were carried into the chamber and an equal amount withdrawn through the four ventilating tubes. At the end of sixty-five minutes the deposit on plates 1 and 2 was very scanty. A small number of crystalline particles were deposited on plate 1, and a still smaller number on plate 2. The amount of arsenic recovered from plate 2 was 198 mmg.—*i.e.*, about one-third of the amount which had been recovered from the plate in the same position in the first experiment. This experiment was repeated with a current of air dried over sulphuric acid, with a similar result.

A considerable amount of fumes had, therefore, been removed by the ventilating tube, but as the cylinder which served as a hood was freely open at the bottom, some heavier parts of the fumes had not been carried away. The velocity of the air passing through the ventilating hood was only about 23 cm. per minute.

These preliminary experiments showed that, in order to prevent the passage of arsenic trichloride into the air, a ventilating hood open at the bottom, though useful, was not sufficient. The tendency which the greater part of the fumes have to rise even when helped by an ascending draft of moderate velocity is not sufficient to prevent the contamination of the air by the fumes which have a tendency to take a down-

ward direction. Although it seemed probable that this difficulty could be overcome by having resort to a draft of greater velocity, it appeared desirable to devise a less expensive method.

With this object, the apparatus shown in Figure 7 B was constructed. This consisted of a bell jar 22,000 c.c. in capacity, in which was suspended a glass

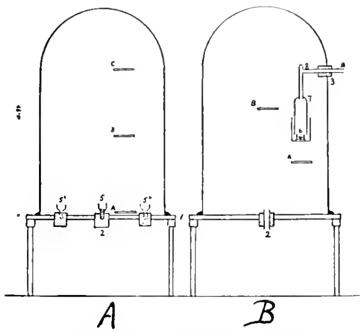

Fig. 7A.—Bell jar arranged for studying production and removal of arsenic trichloride fumes. (Scale 1 to 13.)

1=base glass plates. One of plates has only one central hole 2; the other plate has two holes. (In diagram A the three holes have been represented diagrammatically as in one plate.) 2=central opening closed by cork holding small cup 5 containing arsenic trichloride. This may be replaced after a short time by a similar cork with a small cup containing water, ammonia, or other chemicals. 5′ and 5″=two cups used in experiments in which arsenic trichloride and some other products were exposed simultaneously. A, B, and C=test plates.

B. Arrangement adopted in ventilation experiments. 6=capsule containing arsenic trichloride resting on bottom of outer cylinder. 7=inner cylinder acting as ventilating hood. 8=outlet tube connected with aspirating flask.

cylinder, 7, serving as ventilating hood open at its lower end and connected at its upper end with an outlet or ventilating tube. The vessel containing arsenic trichloride, 6, was placed at the mouth of this ventilating hood in the bottom of a cylindrical vessel of larger diameter than cylinder 7; the lower end of this external vessel was closed and its sides rose about halfway up the ventilating hood which was, therefore, surrounded by an outer cylinder, the mouth of which was directed upward, so that when a current of air passed from the large chamber to the outlet tubes it was forced first to flow downward toward the mouth of the hood ascending through the hood itself.

The following experiment was made with this apparatus:

After about 1.5 gm. of arsenic trichloride had been dropped into capsule 6 through tube 8, the tube was connected immediately with an aspirator and air was made to pass through the system at the rate of 500 c.c. per minute. Some ammonia was then introduced through opening 2 in the bell jar. Almost immediately dense white fumes were observed in the hood (cylinder 7) and in the outlet tube, as well as in the lower part of the outer cylinder guarding the mouth of the hood. The air of the jar remained quite clear, and the test plates A and B remained bright and apparently free from deposit.

When the jar was opened at the end of twenty minutes the test plates examined under the microscope appeared to be free from deposit, but a distinct trace of arsenic was detected on chemical analysis of the washings of the plates.

Fresh test plates were then introduced under the bell jar, and the ventilating apparatus was disconnected from the aspirator, and the chamber left unventilated for twenty minutes. At the end of this time the test plates were found to be covered with a scanty white deposit and their washings contained 178 mmg. of arsenic (as arsenic trioxide).

As these results were not quite satisfactory, it appeared desirable to take advantage of the action which water,

or water vapor, has upon arsenic trichloride. In order to do this the bottom of the outer cylinder was covered with a thin layer of water over which the air admitted to the hood 7 was forced to pass. The ventilating tube outlet 8 was then connected with a water pump, and the amount of air passing through the chamber and the hood measured by means of a gas-meter. As in the previous experiments, test plates were placed below and at the side of the hood covering the arsenic trichloride. The experiment lasted three hours and fourteen minutes, during which time 244,000 c.c. of air passed through the ventilating apparatus, or on an average 1,250 c.c. per minute. The area of the space between the inner and outer cylinders being 7.8 cm. square, the velocity of the air entering the hood was about 160 cm. per minute. The temperature of the air was 16°C. The amount of arsenic trichloride evaporated was about 0.4 gm. At the end of the experiment the test plates were quite clear and their washings contained no appreciable amount of arsenic.

For control purposes test plates were exposed in the same chamber, after the hood had been lifted several inches above the arsenic trichloride, and after the lower cylinder with the thin layer of water at the bottom had been removed from under the arsenic trichloride and placed at some distance from it. After these alterations a current of air was made to pass through the chamber for two hours at the same rate as before. (This was discontinued during the third hour.) After three hours' exposure in the chamber there was a distinct deposit on the plates, the washings of which yielded 360 mmg. of arsenic.

This last experiment shows how arsenic trichloride fumes can be prevented from contaminating the air around retorts, conduits, tanks, etc. At the same time, special ventilating arrangements are needed to remove fumes which arise when arsenic trichloride is necessarily exposed to the air in the filling of drums or the sampling of their contents. Air containing fumes so removed could be purified by a fine water spray before being discharged in the atmosphere. All persons employed on this work should wear some impervious general clothing, and only experience can show whether they should not also wear suitable gas masks.

Some Effects of Personal Accidental Exposure to Arsenic Trichloride

The experimenters sustained accidental local and general exposure in the laboratory and when visiting the works in the course of this inquiry. On two occasions small necrotic lesions of the epidermis were experienced, which resembled those obtained experimentally with animals.

Exposure to fumes was followed by pharyngeal and laryngeal irritation, headache, giddiness, nausea alternating with feelings of excessive hunger (gastric irritation), abdominal discomfort, pains in the thighs, legs and feet, and edema of the feet. At the same time the urine, which normally contained as a maximum 5 mmg. of arsenic trioxide per 100 c.c., was found to contain 20 mmg.

These personal experiences confirmed the results of the experiments and assisted in their interpretation.

Summary

A worker employed in the manufac-

ture of arsenic trichloride, upon whose leg this chemical was spilled, died of acute arsenicism; and others so employed were found to be exposed to risk of poisoning.

The hydrochloric-copper and the iodine volumetric methods of estimating the presence of arsenic, which were used in this inquiry, are described. Arsenic was found in the hair and urine of persons and animals exposed to arsenic trichloride fumes.

Innunction and inhalation experiments on animals are described. In both series of experiments death due to arsenical poisoning followed.

Water vapor was found to decompose arsenic trichloride, forming a light precipitate of oxychloride.

The air of places where arsenic trichloride was prepared or handled was found to contain arsenic compounds, and arsenic was found in the hair and urine of men employed.

Risk of poisoning can be avoided by providing with a water seal all places from which arsenic trichloride can possibly escape.

The experimenters themselves experienced local and general symptoms of poisoning during the inquiry.

BOOK REVIEWS

Tuberculosis and the Community. By *John B. Hawes, 2d*, M.D., Director, Clinic for Pulmonary Diseases, and Assistant Visiting Physician, Massachusetts General Hospital; Instructor, Graduate School of Medicine, Harvard University; Consultant in Diseases of the Lungs, New England District U. S. Veterans' Bureau; President, Boston Tuberculosis Association; Member, National Tuberculosis Association, Massachusetts Tuberculosis League, etc. Cloth. Pp. 168 with preface and index. Philadelphia and New York: Lea & Febiger, 1922.

This monograph deals with the problem of tuberculosis as it affects the whole community, rather than with tuberculous disease in the individual. It is written in a clear, simple, forceful style and in language readily intelligible to the layman interested in tuberculosis as a social problem. The brevity of the monograph, its clear presentation of scientific facts, and its readable character make it a useful book for teachers of hygiene to recommend to their students.

Chapters are devoted to the frequency, the transmission, and the cost of tuberculosis; to the care of consumptives; to tuberculosis and its relation to schools and schoolchildren, to tuberculosis and housing; to tuberculosis and occupations; to the careless and incorrigible consumptive; to the tuberculosis program for small cities and towns; and to the present needs of the tuberculosis campaigns. —*Katherine R. Drinker.*

Public Relief of Sickness. By *Gerald Morgan.* Cloth. Pp. 195 with index. New York: The Macmillan Company, 1922.

This book is perhaps not intended for the general public nor even for the medical profession as a whole; but rather for thinking citizens of all classes who can believe that it is possible by legislative measures to abolish the poverty arising from disabling illness, and to provide adequate medical care. It is simply and thoughtfully written, and lucid in outline and development.

The author's thesis is that heretofore legislation has been more or less unsuccessful, because of the attempts to cover cash benefits and medical treatment by a single legislative proposal. He begins with a discussion of the complex relation between sickness and poverty, and, quoting conservatively from the Report of the Health Insurance Commission of the State of Illinois, shows that roughly 25 per cent. of social degradation is due to illness among the workers whose income is on the edge of the deficiency limits. In the next chapter he considers the opportunity for satisfactory medical treatment available to the person of moderate means, and he finds that it is very rare except in the large centers. Only in the pay clinics with paid personnel is it satisfactory with regard to the specialties and to self-respecting relations between patient and physician. The amount

of insurance against illness in this country is insufficient and limited to fraternal orders. to workmen's societies of unions or foreign groups, or to establishment (factory) funds. It is rarely carried with commercial carrier.

The author shows how solution of the problem has been attempted: first, in Denmark by state encouragement and subsidy of voluntary associations which now include 30 per cent. of the population. In an endeavor to extend this service, however, the dues have been made so low as to allow only meager sick benefit payments and limited medical service. In Germany the compulsory insurance is administered by local funds paid partly by the employer and partly by the employee, but in poorer communities where wages are low medical service and benefit payments are small. There have been many doctors' strikes. The benefits paid are half the weekly wage; and for the poor this is inadequate. There is no medical service to the families of the insured.

The English system is a compromise between older workmen's societies, Poor Laws of Relief, government, and medical interest. It is administered by two forms of organization; the first cares for the cash benefits, the other for medical treatment. The expense is shared by workman, employer, and government. Cash benefits are the same for all men but for women they are somewhat lower. Medical benefits are provided without cost to the worker. The panel doctor is paid per capita, and hasty work is encouraged. No allowance is made for special examination or treatment.

In the author's opinion all the above attempts fail by trying to include cash relief and medical aid in a single legislative measure. It is possible to calculate the amount of cash required for benefits in a large group by means of life insurance actuarial tables; but the cost of sickness, with constantly changing medical technic, cannot be calculated.

In New York, legislation was proposed which would provide cash and medical care to all, except agricultural and domestic workers. This was based on a maximum wage of $12, which is very low; but it lessened the burden of the low wage earner by throwing the full cost of insurance on the employer who paid less than $5 per week. The system was to be administered by Associations (Funds) composed of and managed by employers and their employees, under state supervision. Medical care was included. It is the author's opinion that by eliminating the medical benefits altogether, cash benefits could be raised to an adequate amount without extra expense—the cost to be about 1 1/3 per cent. of total wages.

Medical care should, then, be provided by health centers with paid staff and workers. Where localities are unable to finance these themselves, the state should aid them; but these centers would be the property of the community and would furnish scientific medical care to all classes of taxpayers at a reasonable price.—*J. W. S. Brady.*

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INDUSTRIAL DERMATOSES*

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THE subject of industrial medicine has come to the front more and more during the past few years. This is not without reason when one considers the enormous number of patients suffering from some physical disturbance brought on by their occupation; and in no part of the field is this more commonly noted than in connection with diseases of the skin. According to Knowles industrial dermatoses constitute one-sixth of the total number of diseases of the skin; Hazen gives the figure as one-fifth, Oppenheim as four-eighteenths, and Prosser White (1) as one-fourth. In a recent lecture before the Harvard Medical School, White (2) spoke of at least forty-six different diseases of the skin that are well known among approximately 120 different occupations; and Ormsby (3), after inspecting several plants where binding twine is manufactured, found that about 25 per cent. of the workmen were affected with dermatoses due to their occupation. In fact, an investigation of industrial establishments in general would reveal an astounding amount of occupational skin disease.

Since skin affections are so common, it will be of value to us to look, for a moment, into the subject of their etiology. Many different classifications have been used in considering these affections, but we know of none that is any simpler or any more comprehensive than that suggested by Pusey, who groups these diseases according to their predisposing causes and their exciting causes.

There is no question that personal susceptibility has something to do with the dermatitides seen in persons carrying on certain types of occupations. Why one gardener is poisoned by the primrose and another is not; or why one person has a dermatitis from working with rosewood, while another person has no ill effects, is difficult to explain. To a large extent we must explain it as a case of personal susceptibility or, perhaps, a type of anaphylaxis. It is certainly true

*Read at the joint meeting of the Industrial Hygiene Section of the American Public Health Association and the Ohio Association of Industrial Physicians, Oct. 18, 1922. Received for publication Oct. 21, 1922.

that once a person has been poisoned by a particular substance his susceptibility to it is undoubtedly increased. It has been noticed that workers who have once been sensitized to satinwood almost have an anaphylactic shock, not only of the skin but of the entire system, if they even enter the room where this wood is being worked. We have all heard of people who are susceptible to such substances as buckwheat flour. Is not the personal susceptibility of industrial workers much the same?

In addition to personal susceptibility, however, there are certain other predisposing causes which must be mentioned. Why is it that the colored man is so free from industrial dermatoses, in comparison with the white man? Is it due to the fact that his skin is more oily, and consequently gives him better protection? This is undoubtedly true, and it may also explain, to a certain extent, why the person with a dry skin is so much more susceptible to industrial dermatoses than is the person with an oily skin. The brunette, whose skin approaches more nearly that of the negro, is probably less susceptible than the blond. Again we find that in certain industries the old person or the person with the senile type of skin suffers more from skin affections than does the youthful person. This is probably due to lack of oil in the skin, and we feel quite free in saying that in many instances this predisposing cause, together with personal susceptibility, has a great deal to do with the dermatoses seen in the average industrial plant.

All dermatoses cannot be explained in this way, however, and other reasons for their presence, such as the exciting causes, must be sought. It is a well-known fact that leprosy is a disease of the tropics, and is exceedingly uncommon in the average locality in the temperate zone. This applies also to a number of other diseases. There is no question that the climate has some effect, especially in producing the dermatoses which are excited in part by excessive perspiration. This brings up the subject of temperature, which is closely allied to climate as an exciting cause. During the war we heard of the trench feet of the soldiers, a disease undoubtedly due to deficient circulation and to the cold. Among men exposed to the heat of a furnace in their daily work, also, there frequently occurs an erythematous dermatitis on the exposed parts of the body.

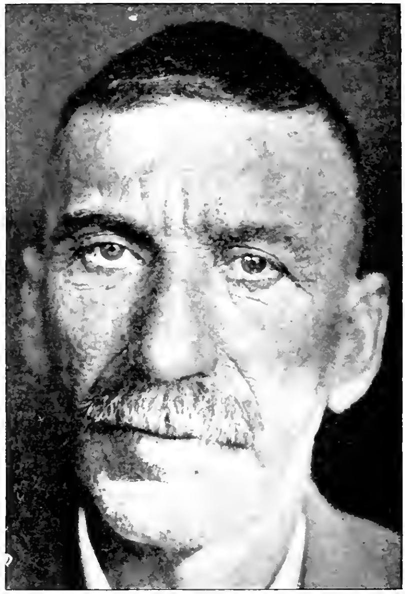

Fig. 1.—Case of hypersusceptibility, in a farmer, to horse dandruff.

Mechanical pressure likewise is the cause of many trade skin changes, such as the hygromata of tailors and carpenters, the "beat" knee of the collier, and

the "beat" hand of the miner.

Parasites may also be the exciting cause of puzzling complaints in industrial workers. Legge (4) describes a dermatitis of the hands and exposed parts of the body, gradually spreading

FIG. 2.—Dermatoconiosis, from metallic dust, in a worker engaged in filling boxes with tacks. One week after stopping work, the back was practically well.

over the entire body, seen in packers in some tile plants in California. Careful examination of the straw in which the workmen packed the tile revealed the fact that it was infested with pediculoides ventricosus. Elimination of these organisms from the straw caused the entire disappearance of the dermatoses. Numerous other examples of inflammations of the skin due to parasites might be mentioned.

Again, many of these conditions may be explained from a purely mechanical standpoint. Skin affections of this kind we term dermatoconioses. They are frequent among persons working with powders of different types, especially finely divided powders. As examples, we may cite workers in zinc oxide powders, as in a group recently reported by Turner (5), and workers with pyrethrum, iron ore dust, and copper dust. The particles of powder which are floating about in the air, alight on the skin and clog the pores of the sebaceous and sweat glands. This irritates the skin and then secondary infections set in.

We have recently seen a patient with a generalized follicular eruption on the exposed parts of the body who stated that her sole task was to fill paper boxes with tacks from an automatic machine. She said that there was no oil in her work but that there was a great deal of fine metallic dust flying around and

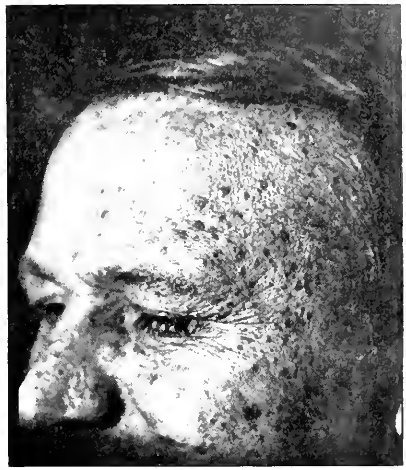

FIG. 3.—Keratoses in a carbon worker. This patient has not worked with carbon for twenty years. Several areas have undergone malignant change.

alighting on her skin. This was clearly a case of dermatoconiosis. Undoubtedly some of the skin affections seen in workers with tar and carbon can be explained in the same way.

During the war many cases of trinitrotoluene dermatitis were observed. The condition was due primarily to the fact that the pores of the skin became clogged with the powder, and secondarily to the fact that the powder

was covered with minute, sharp, spicules which seemed to irritate the skin. This type of dermatitis has been carefully studied and reported on by Prosser White (1) (6) and others. Many of the cutaneous affections seen in candy workers, workers in flour mills, and grocers are of the same etiological group.

FIG. 4.—Chronic dermatitis in a carbon worker.

There is no class of industrial skin diseases in which the mechanical theory of the exciting cause plays a more important part than in the class of dermatoses resulting from the use of cutting oils. In order to minimize the heat from friction in the use of high speed metal cutting machines in industry various combinations of oils and lubricants have been devised. They contain animal and vegetable oils, free fatty acids, so-called sulphonated oil (which is oil treated with sulphuric acid), etc. As an economic measure it has been the custom in industrial plants to use these oils over and over, with the result that sooner or later the skins of many of the workmen become severely inflamed and infected.

This subject has been carefully studied for many years. One of the best of the early contributions on the subject was by Shie (7). He concluded that the cutting oils used among lathe workers became secondarily infected by repeated use; moreover, the workers expectorated into them, and otherwise contaminated them, so that they became loaded with bacteria which would infect the skin of the workmen, especially if they had any open skin lesions due to flying particles of metal, etc. Shie checked up his work carefully from a bacteriological standpoint. He also found that in the plant which he studied the wounds were reduced from 5 per cent. to less than 0.5 per cent. by treating the oils with a combination of heat and chemical disinfectant. His findings have been reviewed by the Houghton Research Staff (8) and by Page and Bushnell (9). McLachlan (10) has recently published an independent study on the same subject, in which he corroborates Shie's findings, and in addition lays stress on the presence of free fatty acids in the cutting oils, and on personal and occupational hygiene.

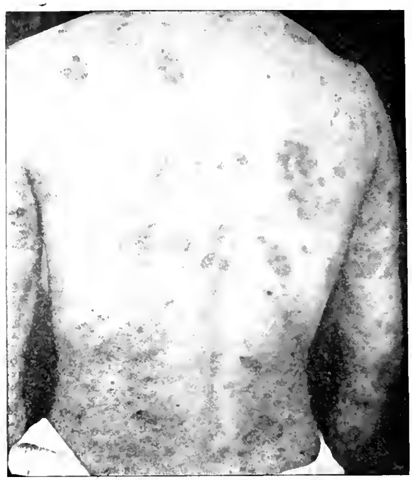

FIG. 5.—Generalized grocer's dermatitis.

Perhaps the recent investigation of McConnell (11) is the best that has thus

far been made. Under the auspices of the United States Public Health Service he made a study of the larger plants in Chicago, Minneapolis, and St. Paul, in order to ascertain the exact causes of the dermatoses due to the use of oils and lubricating compounds. In his investigation he found that among 2,060 workers 27 per cent. had a dermatitis characteristic of this type of work. The most frequent symptom was the presence of an affection known as "oil acne," appearing primarily as comedones at the orifices of the hair follicles and seen especially on the exposed parts of the body and over the thighs where the oil from saturated clothing comes into intimate contact with the skin. This eruption is usually accompanied by severe itching, and there may be secondary infections resulting in large furuncles and abscesses. As a result of his investigation McConnell came to the conclusion that while it was true that infection might have something to do with these dermatoses; that while it was true that the free fatty acid and free sulphuric acid present in the cutting oils and lubricants might irritate the skin to a certain extent; and that while it was also true that the pickling compounds present on the metals to be worked might irritate the skin of the workmen; yet, in his estimation, the mechanical theory alone was sufficient to explain the presence of most of the lesions. He found that the affection was more frequent in persons with dry skins, and that in these persons it was caused by the mechanical obstruction of the sebaceous ducts. These findings apply likewise to his report on the dermatoses found among printers (12).

FIG. 6.—Dermatitis of the hands in a candy worker.

FIG. 7 Oil dermatitis of the hand. Patient works at an oil tempering bath.

It is true that many of the industrial dermatoses can be explained from the mechanical standpoint, yet many of them must be considered from the chemical standpoint as well. As instances, may be cited the dermatoses among workers with lacquer, which is made from Japanese and Chinese rhus; among leather workers, who come into contact with arsenic, hydrochloric acid and potassium dichromate; among painters using methyl alcohol, with its poisonous

pyridine; and among paper-hangers who come into contact with aniline dyes. In this section of the United States we see many employees of rubber plants working with such poisonous aniline derivatives as para-phenylenediamine and thiocarbanilide, and with formic acid and formaldehyde, decomposition products of hexamethylenetetramine. In these industries the dermatoses are due partly, at least, to the action of the chemical irritant. Personal susceptibility may, however, be a contributory cause. Among nurses and physicians there occur numerous instances of still another type of chemical irritation, in which, also, personal susceptibility plays a part. We refer to the erythematous dermatoses seen so frequently on the hands of nurses and physicians as a result of using bichloride of mercury, iodine, and various chlorine preparations.

McConnell and others have found that in many instances there is still another thing to be considered as an etiological factor in industrial dermatoses—namely, the fact that often workers use such strong soaps and such harsh stiff brushes to remove the oils, dyes, metallic dust, etc., that they injure their skins.

No paper on industrial dermatoses today would be complete unless it included reference to the dermatitis seen in physicians and X-ray workers. Despite a great deal of educational propaganda we still see X-ray equipments installed with inadequate facilities for the protection of the operator. Probably in the next few years we shall see even more damage done by radium. The writers are personally acquainted with several physicians and radium workers who have been irreparably injured by exposure to these elements. We believe that there should be stringent laws for the protection of workers with X-rays, especially, and also, if possible, for the protection of workers with radium.

Finally, there is still one other group of causative factors in connection with industrial dermatoses—namely, the bacterial group. As examples of skin diseases of bacterial origin we may mention anthrax, which occurs among workers with leather and with brushes, and mycotic diseases, such as blastomycosis and sporotrichosis, which are fairly common in the meat packing industry.

In fact, if we look over the entire subject of industrial medicine, we find that industrial dermatoses and their causes are innumerable. The symptoms are likewise numerous, though as a rule they are not so numerous that they cannot be quite readily diagnosed. The patient generally gives a history of their acute onset, especially of their appearance soon after he has started a certain occupation, but not infrequently of their appearance after he has worked at the same occupation for some time. Why a man can work with a certain type of wood, for example, for several months without displaying any symptoms, and then suddenly show symptoms of acute poisoning of the skin, is difficult to explain. Nevertheless, instances of this type are not uncommon.

The lesions of industrial dermatoses are usually sharply limited to the exposed parts of the body, and this fact is of assistance in the diagnosis. Sometimes in persons having the condition for a long time, however, the lesions may become more generally distributed. In persons working with oils, the trousers, especially over the thighs, may become saturated with the oils, and a dermatitis of this area as well may result. In persons working with powders such as lamp black, or in chimney-sweeps,

the powder may get into the clothing as well as on the exposed parts of the body, and may bring about some generalized type of dermatitis. As a rule, however, the process is localized on the exposed parts, and this should suggest the possibility of an external irritant as the source of the affection. It is seldom that other conditions have to be considered. Occasionally one will see a frequently recurring eruption sharply limited to one limb, in an area easy to reach, which may be diagnosed as dermatitis factitia. Some time ago we saw such a case. The patient had an indolent ulcer on one forearm which had lasted for years and had cost her firm thousands of dollars. She was accustomed to keep it open by the application of a little phenol from time to time. Fortunately, this type is rare. Occasionally a seborrheic dermatitis may be brought into the question, but it is rare for a seborrheic dermatitis to be limited to the exposed parts, and especially for it to come on so acutely and without the symptoms involving the scalp.

Once a diagnosis has been made, the question of treatment arises. Here several things should be considered. In the first place, the cause should be ascertained and, if possible, should be removed. It will probably be necessary to transfer the workman affected to another part of the plant, or perhaps to give him a short rest. The treatment of the condition, however, will be one of the simpler things to be considered, and should consist in local application of non-irritating, soothing remedies. As a rule ointments are contraindicated, particularly in the acute stage. Rather the use of lotions or hot soaks—perhaps of potassium permanganate in water, 1:5,000—is recommended; or the use of 1 per cent. aluminum acetate in distilled water. Boils and abscesses should be treated according to the surgical indication. After the acute symptoms have subsided, it may be justifiable to use a mild, soothing ointment, such as 5 per cent. boric acid ointment. Many times in thickened areas of chronic inflammation we find the local use of the X-ray in unscreened doses of approximately one-half skin unit to be of great value. In colored people, because of their tendency to keloids, we advise the prophylactic use of one or two X-ray treatments after lacerations.

The hygiene of industrial dermatoses is the point on which we should lay the greatest stress, as prevention of the condition is much easier than its cure. We believe that there is not close enough supervision of industrial workers. Shower baths should be available in all industrial plants, and it should be compulsory for workmen to use them daily—certainly, after finishing their work at night. They should not be allowed to wear clothing saturated with oils or filled with powders which have the capacity to cause chemical or mechanical injury to the skin. Fresh clothing and frequent bathing will prevent most industrial dermatoses. On the other hand, workmen must not overdo bathing to the extent of injuring the skin.

The prophylactic measures suggested by McConnell seem to us so important that we are giving them in full.

1. On entering the plant each workman should wash the hands and forearms thoroughly with warm water, using a sawdust and liquid-soap preparation to assist the cleansing process.

2. After drying the skin with an individual towel he should apply either lanolin alone or lanolin and castor oil, and rub it well into the skin.

3. The foreman should inspect each work-

er as he enters the workshop, to insure the efficient carrying out of the foregoing.

4. At noon, before eating luncheon, the workmen should wash the hands and forearms with warm water and soap.

5. On returning to work they should repeat the morning schedule of washing and applying the lanolin preparation.

6. At the end of the workday they should wash the hands and arms with warm water and soap and dry them. No emollients should be applied unless actual abrasions are present, in which event proper dressings should be applied. The lesions on the thighs can best be prevented by wearing aprons impenetrable to oils.

In plants inspected by McConnell and in which his instructions were enforced, after eight months no industrial dermatoses were found; while in plants where the routine measures were adopted but were not enforced, 21 per cent. of the men still had dermatoses. This shows the efficacy of these recommendations. In concluding, we wish to emphasize the importance of cleanliness in the hygiene of industrial dermatoses.

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SUMMARY OF NOTES ON TWO FATALITIES DUE TO INHALING PHOSGENE ($COCL_2$)*

THE LATE SHERIDAN DELÉPINE, M.B., C.M., M.Sc.

THE two men whose cases are here reported were employed during the war in factories where they were exposed to the risk of inhaling phosgene.

CASE 1.—X was seen by the works physician on March 27 at 3:15 P.M.; after that he went to work but returned very soon, obviously suffering from gas poisoning, and with his clothing saturated with phosgene. He was treated immediately and was attended until 5 P.M.; his pulse was then good, and, as he was much better, he was sent home. At 9:30 P.M. he became worse. He was deeply cyanosed, his respiration was difficult and rapid, and there was frequent coughing and expectoration of a large quantity of frothy mucus. Under treatment he improved and was distinctly better at 1:30 A.M. He had a relapse at 9:30 A.M. on March 28, and he died at 11:15 A.M.

From this brief history it appears that X was well and able to work at 3:15 P.M. on March 27, and that he was gassed about 4 P.M. and died nineteen hours later.

CASE 2.—As the result of the explosion of a cylinder containing phosgene gas, which took place at 3:30 P.M. on June 11, Y was exposed to the action of the gas and one of his hands had to be amputated at the wrist. There was little hemorrhage, either before, during or after the operation, and at the end of the operation the patient appeared to be comfortable. The breathing became distressed and the pulse rapid at about 10 P.M., and death occurred at 1:30 P.M. on June 12, twenty-two hours after the accident.

The various organs of the body in both cases were submitted for examination; the findings are summarized in Table 1.

REMARKS

The lesions observed in the two cases reported fall under three categories: (1) Pre-existing lesions (*i.e.*, lesions not attributable to phosgene poisoning); (2) primary lesions due to inhalation of phosgene; and (3) secondary lesions, which may be considered as the physiological consequences of the primary lesions.

Pre-Existing Lesions

Heart.—In both cases (and more particularly in the case of Y) the heart was larger and heavier than the normal average, and its cavities were slightly dilated. There was, however, no chronic cardiac or extra-cardiac lesion that could account for any degree of hypertrophy or dilatation of the heart, except the limited fibrosis of the apices of the lungs in one case. As the body weight of the men is not known, no inference can be drawn from the heart weight.

Lungs.—In the case of X the apices of both lungs were in a state of fibrosis (fibroid pneumonia), which was probably due to healed tuberculosis; the amount of lung tissue thrown out of use

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TABLE 1.—SUMMARY OF LESIONS FOUND IN TWO CASES OF PHOSGENE POISONING

Organ or Material	X (Lesions 48 Hrs. after Death)	Y (Lesions 31 Hrs. after Death)
Heart		
Without blood	295 gm., large, flabby, semi-contracted.	340 gm., flabby, semi-contracted.
Blood	170 gm., soft homogeneous clot; normal. Color brightening on exposure to air.	170 gm., homogeneous clot. Venous looking, brightening rapidly on exposure to air.
Pericardium	Normal	Normal.
Epicardium	Normal.	Milk spots near apex of left ventricle.
Endocardium and valves	Normal; blood stained.	Normal.
Myocardium	Granular degeneration (incipient necrosis?); congestion.	Granular degeneration; slight congestion.
Aorta		
First part	Limited soft atheroma.	Limited soft atheroma.
Lungs		
With exudate in bronchi	1,559 gm.	1,310 to 1,350 gm.
After escape of exudation	1,460 gm.; right, 750 gm.; left, 710 gm. Lungs remain distended with air, as in inspiration.	1,190 gm.; right, 644 gm.; left, 546 gm. Lungs remain distended with air, as in inspiration.
Pleura	Old fibrous adhesions at apices of both lungs. Subpleural emphysema.	A few loose fibrous adhesions on outer aspect of left lung. Thin deposit or precipitate on serous surface. Petechial subpleural hemorrhages. Subpleural emphysema.
Parenchyma	Fibroid pneumonia of both apices. General congestion. Small hemorrhages at basis of right lung. Disseminated alveolar edema alternating with alveolar (vesicular) emphysema.	General congestion; color bright red. Disseminated alveolar edema alternating with alveolar (vesicular) emphysema.
Interlobular tissue	Interstitial (interlobular) emphysema.	Interstitial (interlobular) emphysema.
Air passages	Capillary bronchitis (and obstruction of terminal bronchi, under 1 mm. only). Acute catarrhal (desquamative) bronchitis, tracheitis, and laryngitis, characterized by extensive desquamation and bronchorrhea.	Capillary bronchitis (and obstruction of terminal bronchi under 1 mm.). Acute catarrhal (desquamative) bronchitis, tracheitis, and laryngitis, edema glottitis and edema of bronchial mucosa. Acute bronchorrhea.
Liver	Total weight 1,326 gm. Small, normal in shape; generally pale owing to pale color of portal zone of lobules.	Total weight 1,601.7 gm. Normal in shape; generally purplish red in color; central parts of lobules congested.
Capsule and interlobular tissue	Normal, irregularly congested.	General slight increase (incipient cirrhosis?).
Portal vein and branches	Distended with blood; normal in appearance.	Distended with blood; normal in appearance.

TABLE 1 (*Continued*)

Organ or Material	X (Lesions 48 Hrs. after Death)	Y (Lesions 31 Hrs. after Death)
Liver (cont.)		
Hepatic vein and branches	Distended with blood: normal in appearance.	Distended with blood: normal in appearance.
Parenchyma	Hepatic cells, small, granular, pigmented; evidence of very early stage of fatty degeneration. No distinct necrosis. No deposit of "free iron."	Hepatic cells, small, granular, slightly pigmented; doubtful evidence of early fatty degeneration. No distinct necrosis. No deposit of "free iron."
Bile duct and gallbladder	Apparently normal. Moderately filled with dark brown, thick bile.	Apparently normal, except a few of the terminal ducts, which are increased in length (effect of cirrhosis). Moderately distended with dark, greenish brown bile.
Kidneys		
Right	115 gm.	120.5 gm.
Left	130 gm.	134.6 gm.
Both	245 gm.	255.1 gm.
	Normal in shape and size: general congestion: small retention cyst under capsule of right.	Normal in shape and size; general congestion, but labyrinth pale.
Capsule	Slightly thickened.	Normal.
Interstitial tissue	Normal in amount.	Slight increase at places under the capsule.
Renal vessels	Congested, especially vasa recta and malpighian tufts.	Congested, especially vasa recta and malpighian tufts.
Parenchyma	The epithelium of most of the convoluted and spiral tubules is necrosed. In a few groups of convoluted tubules a slight degree of fatty degeneration is noticeable. The straight and excretory tubes are less affected. No "free iron" in any part of the organ.	The epithelium of most of the convoluted tubules is necrosed. Desquamation in a few small groups, with slight amount of fatty dedegeneration. Collecting tubules less affected. No "free iron" in any part of the organ.
Pelvis, Ureter and Bladder	Mucous membrane much thickened.	Mucous membrane much congested.
Urine	Pale greenish yellow, turbid. Sediment abundant; vesical epithelium and red blood corpuscles present.	
	Specific gravity 1.020. Reaction acid. Albumin abundant.	
Spleen	90 gm. Normal in shape. Evidence of congestion.	102 gm. Normal in shape; somewhat flabby; somewhat pale.
Stomach	Congestion of all coats. No obvious histological lesion.	General congestion.
Duodenum	Same.	Same.
Blood from Pulmonary Vessels	Oxyhemoglobin spectrum; carboxyhemoglobin, no typical absorption bands observed. Oxyhemoglobin entirely reduced by Stokes' fluid.	
Exudate and Tissue from Lung Parenchyma	0.49 per cent. chlorine present.	

was, however, inconsiderable. The remainder of the lungs was free from chronic lesions. In the case of Y the lungs appeared to be entirely free from chronic lesions. The few loose fibrous pleural adhesions had very little pathological significance. Town anthracosis was well marked, but not excessive.

Liver.—In both cases the liver was normal in shape; it was slightly below the average normal weight in the case of X, but this decrease did not appear to be connected with any previous lesion. In the case of Y there was a slight amount of cirrhosis, and this may have accounted for the weight being proportionally greater than in the case of X.

Kidneys.—These organs were normal in shape and size; a very slight amount of fibrosis was observable, but there were none of the lesions characteristic of interstitial nephritis.

Spleen, Stomach, and Small Intestine.—These organs showed no evidence of pre-existing disease.

Primary Lesions Due to Inhalation of Phosgene

The air passages from the larynx down to the terminal bronchi were the seat of lesions attributable to the action of a powerful irritant. The absence of evidence that any other irritant than phosgene had penetrated the air passages justifies the view that the cause of the lesions was phosgene. The laryngeal, tracheal and bronchial epithelium was more or less completely shed. In the larger air passages the basement membrane was generally quite bare. There were no ulcerative lesions. The few epithelial cells remaining attached to the basement membrane and those which, after separation, had remained mixed with the exudate filling the bronchi, were not in a state of necrosis; some of these cells showed evidence of proliferation. Many of the epithelial cells were in a state of mucous degeneration, and it is probable that this condition and the rapid passage of exudate from the mucosa into the bronchi were instrumental in bringing about extensive and rapid desquamation.

The congestion and edema of the mucosa and submucosa, as well as the excessive excretion of mucus by the tracheal and bronchial mucous glands, may reasonably be attributed to the irritating action of the gas.

The obstruction of the terminal nonalveolated bronchi, measuring less than 1 mm. in diameter, by the desquamated epithelium mixed with variable proportions of exudate appears to have been the main cause of the fatal effects of phosgene inhalation.

The lesions observable in the alveolated portion of the parenchyma were partly primary and partly secondary. The intense congestion of the alveolar capillaries, the alveolar edema and also the edema of the interlobular tissue are attributable to a more or less direct action of the irritant. The epithelial or endothelial lining of the alveoli was comparatively little affected; very few alveoli contained an excessive number of desquamated cells. In a few places, however, some of the cells lining the alveoli had been lifted from their places by the exudation. There was an absence of typical croupous exudation. The mucous membrane of the air passages down to the terminal non-alveolated bronchi apparently were more severely affected by the action of the phosgene than were the alveolated passages and the alveoli. This difference can be accounted for on the supposition that the amount of phosgene present in the tidal

air was reduced by dilution with the residual air contained in the alveolated part of the lobules, and probably also by the absorption of a part of the phosgene by the bronchial mucous membrane. The low diffusibility of the gas may also have retarded its penetration.

Secondary Lesions

The other lesions found in the lungs and those found in other viscera appear to be secondary to the obstruction of the terminal bronchi.

The most important secondary lesion observed in the lung parenchyma was emphysema, affecting both the alveoli and the interstitial (including the subpleural) tissue. This emphysema was recognizable in every part of the lungs in both cases, except at the apices of the lungs in the case of X. In a certain proportion of the lobules, which were partly edematous, the distention of the alveoli was not so well marked as in the other lobules in which the amount of exudation was less. In most of the lobules the alveolated air passages were free from exudation and distended with air.

Collapse and consolidation of small areas of lung tissues were very limited in extent. Emphysema in the present cases cannot, therefore, be described as due to the compensatory dilatation which is so common a feature in subacute or chronic bronchopneumonia.

The distention of the alveoli appears to have been due to the mechanical effects of an accumulation of air in the lobules. This was complicated by a passage of the air into the interlobular tissue, the subpleural cavity and, in one case, the pleural cavity itself.

These emphysematous lesions were probably brought about by excessive inspiratory movements combined with gradual blocking of the bronchioles. At first the obstruction of the bronchioles was not complete enough to prevent the passage of some air into the lobules; interference with the normal gaseous exchanges induced increased inspiratory movements which, by reducing the pressure of the air in the partly blocked lobules, caused some of the air in the bronchi to bubble through the material blocking the bronchioles. On the other hand, the elasticity of the lung tissue and the expiratory movements were probably insufficient to overcome the resistance offered to the escape of air imprisoned by the bronchial plugs. It is probable that after a short time the terminal bronchi were so firmly plugged that the passage of air became impossible both during inspiration and during expiration.

The lung, at that stage, was comparable to a mass of small closed air balloons with thin walls partly stretched. The effect of excessive inspiratory movements of the chest wall was to reduce the external pressure sufficiently to cause the rupture of the balloons situated near the surface and more particularly at the thin edges of the lungs, where the effects of expansion of the thoracic cavity could not be distributed among a number of lobules as in the more central parts of the organ.

The rupture of some alveoli was followed by the passage of air into the interstitial tissue, and in one case the serous layer of the pleura gave way and air escaped into the pleural cavity, which was found postmortem to be filled with frothy exudate.

According to this view the emphysema observed in cases of phosgene poisoning is an acute mechanical emphysema caused by the obstruction of

terminal bronchi, to which it is secondary.

This explanation appears to be supported by the symptoms which I experienced after a partly accidental, partly voluntary exposure to phosgene.

On February 2, 1917, I had to conduct some tests at the Army Medical College in London. The room in which these tests were made was partly underground, and was ventilated by an opening near the ceiling and by a door opening upon a passage with windows opening upon a small inner court. At the level of the upper opening an experimental discharge of phosgene was made soon after the beginning of my experiments. Two of the gentlemen who were present were obliged to retire very rapidly. My assistant had a gas mask, but in order to see my recording instruments I was unable to wear a mask.

I came into the room at frequent intervals in the course of three-quarters of an hour, in order to take my readings of the instruments. Beyond some irritation of the conjunctivae and of the larynx I was not much inconvenienced at first, but as the amount of gas increased I found it necessary to hold my breath, and not to remain in the room for more than one minute at a time. Toward the end of the experiment the passage to which I retired between the observations was invaded by the gas, which I was obliged to breathe freely. This brought about a violent fit of incoercible coughing, which forced me to inhale a fairly large amount of poisoned air. A medical colleague who was also watching the experiment from the passage was affected in the same way. We both had to run away; but during the flight we had to stop frequently owing to the violence of our cough. Even when we had reached a portion of the building where other people were not inconvenienced by the gas, we continued to cough so violently that our congested faces were running with perspiration. This lasted, as near as I can remember, for about fifteen or twenty minutes; the cough then became more bearable, and we were able to move about. I felt dazed and weak, and even after getting out into the open air it seemed to me that the air was still heavily laden with phosgene. I continued to improve for another three or four hours; then I began to experience a choking sensation, which I tried at first to relieve by breathing deeply. I found, however, that this made me cough again. After a short time I found it best to expand my chest, and to breathe very rapidly (about forty to sixty respirations per minute). This did not, however, relieve the choking feeling which at times gave me a considerable amount of anxiety. I remained panting in this way the greater part of the night. The same feeling recurred several times during the following day and night; after that my breathing became normal, but for several days I suffered from marked lassitude.

Except during the initial period, the cough was not very troublesome. (From what I heard afterwards my colleague was more seriously affected than I.)

I was too ill during the first night to make careful observations, but the sensation of impending death from want of air has remained engraved on my mind. I was not troubled with much expectoration.

These symptoms seem to have been due to spasm of the small bronchi, and the condition was one which had many of the clinical features of asthma. The smell of phosgene persisted for many hours, as did also a peculiar sensation of irritation in the larynx and trachea. The persistence of the smell seems to indicate that some combination takes place between the gas, or some constituent of it, and the superficial layers of the mucous membrane.

The direct action of the phosgene upon the bronchial epithelium does not seem to have produced actual necrosis of the cells, which had remained *in situ*. The staining reactions of the desquamated cells did not resemble those of cells which had undergone necrobiosis or coagulative necrosis. This finding does not in itself prove that these cells had not been rapidly killed before or after being shed.

The fact that many of them showed evidence of mucous degeneration, however, supports the view that the gas acted as an irritant and not as an agent immediately lethal.

The amount of chlorine found in the lung tissue, including the blood contained in the vessels and the exudation in the medium sized and small bronchi, amounted to 1.9 parts per 1,000 parts of the material examined. No

evidence could be found of the presence of an appreciable amount of carbon monoxide in the pulmonary blood. No methemoglobin was revealed by the spectroscope. These results must be accepted with caution, and should be controlled by carefully conducted experiments on animals, before any hypothesis is based upon them.

The lesions observed in the kidneys, liver, and heart all appeared to be secondary to the state of the lungs caused by the obstruction of the terminal bronchi, and were attributable to interference with the gaseous exchanges in the lungs, and the consequent changes in the circulating blood. The gradual but rapid diminution in the amount of oxygen was probably of paramount importance in connection with the production of necrotic lesions.

The renal epithelium in the convoluted and spiral tubules had suffered most severely. The few renal cells which had survived showed evidence of granular degeneration and early fatty degeneration.

The hepatic cells were less affected but were generally in a state of granular degeneration, with a tendency to fatty degeneration. They were not swollen; on the contrary, many of the cells, particularly in the hepatic zone, were shrunken.

The myocardial cells were in a state resembling that of the hepatic cells. The congestion of all the organs was of the mechanical or passive type, being due to obstruction of the pulmonary circulation caused by the emphysematous state of the lungs.

A remarkable feature of most of the lesions which have been described is the rapidity with which they occurred. X died nineteen hours after exposure to the gas, and Y twenty-two hours after exposure.

Therapeutical Measures Indicated by Pathological Findings

It would appear that as phosgene or the products of its decomposition (probably hydrochloric acid and carbon dioxide) come into contact with the mucous membrane of the larynx, trachea and bronchi, some of the hydrochloric acid is absorbed by the superficial cells, and acts as an irritant. It would, therefore, seem desirable to neutralize any free or partly combined hydrochloric acid in order to limit this irritating action. Neutralization might be effected if an amount of ammonia insufficient to cause marked irritation were contained in the air breathed by the patient.

It appears also that the irritation produced by the gas causes a contraction of the bronchial muscles. This tends to aggravate the effects of the desquamation of the terminal bronchi. If by the use of an anodyne the spasm could be reduced, the number of bronchioles remaining patent would be increased, and the administration of oxygen would become more effective. The inspiratory efforts would become less violent, and the tendency to emphysema would be reduced. Anything reducing the tendency to exudation such as, for instance, the injection of suitable quantities of sugar solution, might also be beneficial.

Summary

1. Exposure to phosgene, like exposure to nitrous fumes, does not give immediate warning of the grave consequences which may supervene within twenty-four hours.

2. Phosgene does not act as a direct lethal agent, but as a powerful irritant to the air passages, setting up profuse

exudation and cellular desquamation which obstruct the terminal bronchioles.

3. The irritation also causes contraction of the bronchial muscles, associated with asthmatic symptoms.

4. Finally, the bronchioles become so firmly plugged that the entry of air into the alveoli becomes impossible; death then results.

5. Treatment should be directed to the reduction of the exudation and muscular spasm, and to increasing the value of the inspired air by the administration of oxygen.

OBSERVATIONS ON THE RELIABILITY OF THE COMF-THERMOMETER (FRESH-AIR GAUGE) AS AN INDICATOR FOR THE COOLING EFFECT OF AIR*

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PREPARED UNDER THE DIRECTION OF

LEONARD HILL, J. J. R. MACLEOD, AND J. SATTERLY

THE fresh-air gauge, or "comf," consists of a cylindrical metal box 18 cm. high and 10 cm. in diameter, in which is inserted an 8 candle-power carbon filament lamp, of known wattage, the lower part of the box being removable for this purpose. On the top of the box is fixed a metal cone which, in its turn, forms a union with a chimney 25 cm. long and 2½ cm. in diameter. There are some holes in the lower and upper part of the box for purposes of ventilation. An ordinary dry bulb thermometer is introduced into the chimney so that the bulb hangs centrally within it at a depth of 9 cm. The thermometer is attached to the top of a chimney by means of a suitable grip. Given a main current of suitable voltage which remains uniform, or which varies only slightly, the 8 candle-power lamp acts as a constant source of heat, while the box and the chimney are cooled by radiation and convection. The instrument is shown in Figure 1.

Observations were taken in Toronto by Miss Eadie in order (1) to obtain, if possible, a relation between the comf and kata-thermometer readings; (2) to determine the agreement between comfs taking the same current; (3) to test the results of altering the number of ventilation holes; (4) to test the rate of adjustment to varying conditions; and (5) to obtain, if possible, a relation between comf and kata in an air current.

Observations to Obtain Relation between Comf and Kata-Thermometer Readings.—The comf was set up in a small room and allowed to heat up until the reading became fairly steady. Then readings were taken at intervals of about five minutes. Kata-thermometer readings were taken simultaneously with those of the comf. Readings of kata and comf were then plotted against time. Figures 2 and 3 are typical of the large number of curves which were obtained in this way. The parallelism of the curves shows that changes in the condition of the air produce similar changes in both the comf and the dry kata-thermometer.

It was found that any disturbance of the wire gauze, which kept the thermometer central, produced a change in the readings. This gauze was, therefore, discarded, and the thermometer was suspended from a hook on the end of a rod which was soldered to the chimney of the comf. The lower end of the thermometer was fixed by means of a small spring of brass wire. New sets of readings were obtained similar to those already described and, from these, pairs of comf and kata readings were selected at random. Figures 4a and 4b show the straight lines obtained by using these

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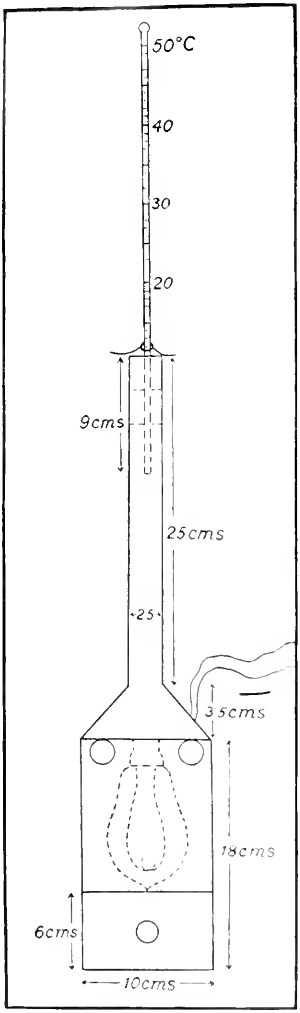


FIG. 1.—Fresh-air gauge or comf.

observations for currents of 0.195 amperes and 0.245 amperes, respectively, the two equations connecting the kata reading K and the comf reading C being $K = 18 - 0.29\ C$, and $K = 16.7 - 0.23\ C$.

Two comfs were set up in a lecture room, one at the back and the other at the front. During the classes readings were taken at the back at intervals of about five minutes, and at the front whenever possible. Readings of the kata-thermometer were taken simultaneously with those of the comf at the back. The current used was practically constant and the comf readings were expressed in millicalories per square centimeter per second by means of the equation obtained. These readings and the kata readings were plotted against time, and the results shown in Figure 5 were obtained. The unbroken line gives comfimeter readings; broken line, kata readings. It will be seen that in all but one case the two curves are almost exactly coincident. The comf at the front of the room always gave a reading about 10°C. lower than the one at the back.

Agreement between Comfs Taking Same Current.—Figure 6 shows the curves of three comfs all taking the same current, 0.280 amperes in the lamp. A and b are for comfs which were similarly made. C is for a comf, the chimney of which was painted black.

Results of Altering Number of Ventilation Holes.—The number of perforations in the conical part of a comf was increased and its curve again found. Figure 7 illustrates the results obtained. Points marked X were obtained from a comf with a single row of holes. Points marked (X) were obtained from a comf with a double row of holes. It is obvious that increasing the number of holes does not affect the ultimate height of the curve of the comf.

Rate of Adjustment to Varying Conditions.—The rate of adjustment to changing conditions was tested (1) with a single row of holes, and (2) with a double row of holes. Readings were

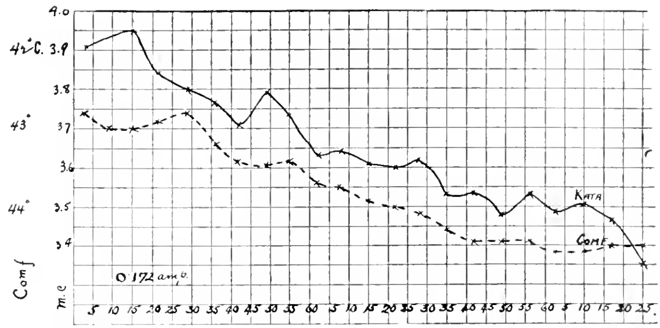


FIG. 2.—Variation with time of heat loss from kata and temperature of comf. Abscissas=time in minutes. Ordinates for kata readings=millicalories emitted per square centimeter per second; ordinates for comf readings=degrees centigrade.

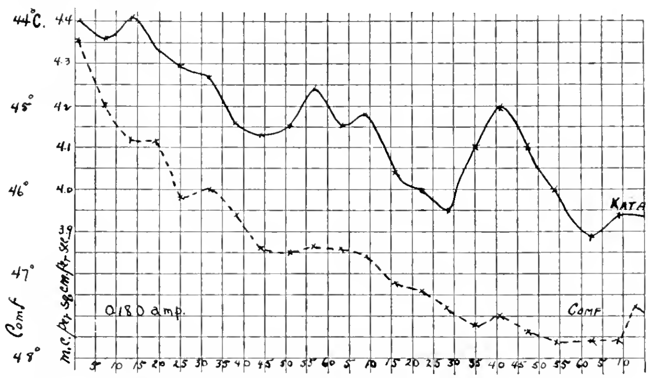


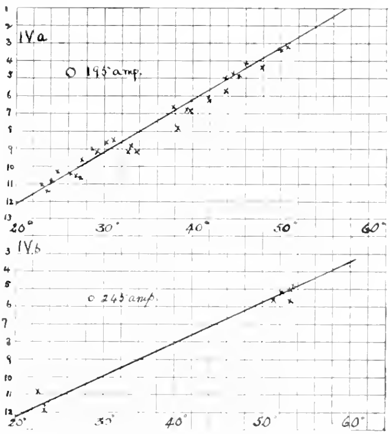
FIG. 3.—Variation with time of heat loss from kata and temperature of comf. Abscissas and ordinates the same as in Figure 2.

taken of the rate of fall of temperature of the comf thermometer in a draft *produced by a fan.* The results obtained are shown in Figure 8. In this chart, comf readings are plotted against time, so that the slope of the curve gives the rate of adjustment. The fact that the two curves are practically parallel shows that increasing the number of holes does not affect the rate of adjustment to changing conditions.

Relation between Comf and Kata in Air Current.—Figure 9 shows the results obtained by taking readings in different degrees of draft. The points marked F were taken in the draft (a large fan was used to produce the draft and conditions were such that both instruments were in the same current of air). The points marked S were taken in still air. This seems to indicate that a straight line is obtained between kata and comf readings in different degrees of draft *down to a certain limiting value* which would not be approached under ordinary conditions; and that this curve agrees very well with that obtained in still air (the dotted line in the chart).

The curve, of course, breaks down when a great degree of draft is reached, for at this point, if the line were continued, the kata reading would correspond with a comf thermometer reading lower than the temperature of the room, which is, of course, impossible.

The instruments used at Toronto were of unpainted tin; those used in



FIGS. 4a and 4b.—Calibration curves of a comfimeter with different currents through the lamp. Abscissas=comf temperature in degrees centigrade; ordinates=millicalories emitted per square centimeter per second.

later experiments were covered with black enamel. The wire gauze referred to in the observations to obtain the relation between comf and kata-thermometer was used in the early form of the instrument in order to keep the thermometer central in the chimney. As a result of these and similar experiments it was afterwards done away with and the thermometer was fixed rigidly at the top of the chimney.

Observations were taken at Hampstead, London, by Mr. T. C. Angus in order to confirm and continue the results of Miss Eadie. A near approximation to a still air chamber was made by using a screen of American cloth

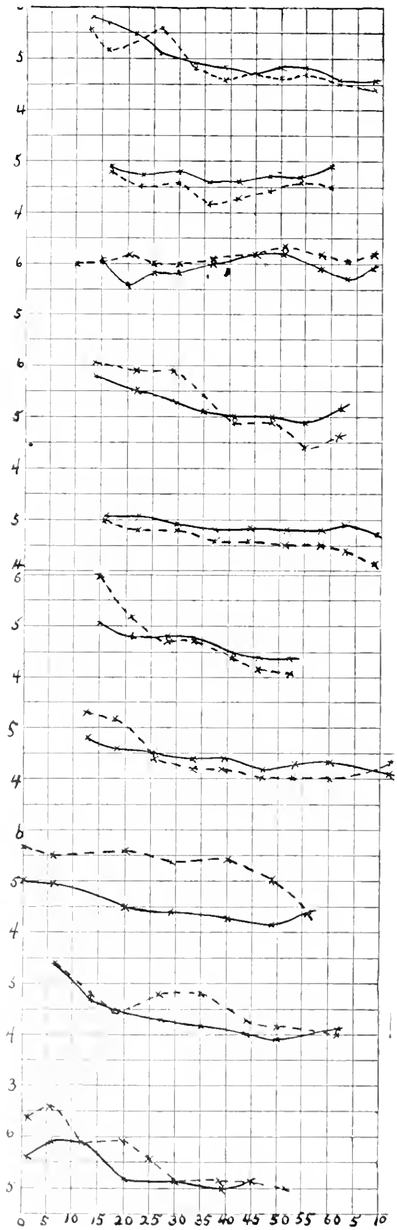


FIGURE 5

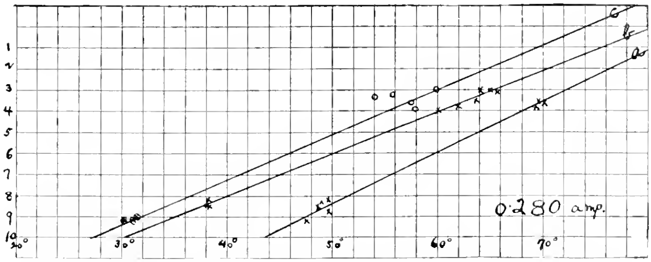


FIG. 6.—Determination of constant of comfimeter. Comparison of three comfimeters with a kata-thermometer under varying conditions. Abscissas= comf temperature in degrees centigrade; ordinates=kata reading in millicalories per square centimeter per second.

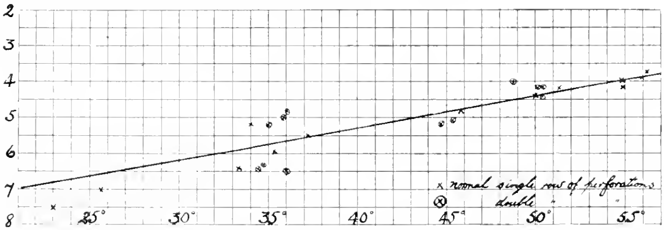


FIG. 7.—Comparison of kata readings with readings of comfimeter (1) having normal row of perforations (marked x); and (2) having double row of perforations (marked (x)). Abscissas=comf. temperature in degrees centigrade; ordinates=heat loss.

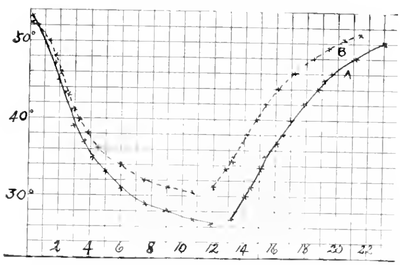


FIG. 8.—Behavior of two comfimeters, A and B. Fan turned on at beginning but stopped after twelve minutes. Abscissas=time in minutes; ordinates=comf temperature in degrees centigrade.

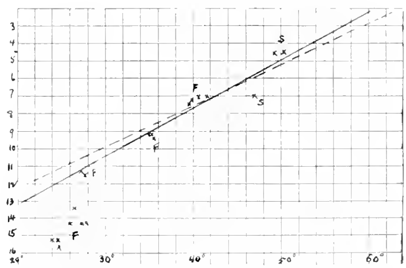


FIG. 9.—Determination of comfimeter constant by comparison with kata. Points xF indicate fan on; points xS indicate still air. Broken line shows a curve previously obtained. Abscissas=comf temperature in degrees centigrade; ordinates= millicalories per square centimeter per second.

enclosing a 4-foot square. This was open at the top and had a celluloid window let in all round about 1 foot from the top, for reading the instruments. Specially selected lamps of 33 to 35 watts were supplied by the Edison-Swan Electric Company both for 200 and 100 volt circuits.

Five comfs were fitted with thermometers which had been tested and were found to read together, and these were placed on a wooden support inside the screen. The connections were taken off in parallel from one lead. Table 1 gives the time, the temperature inside

and outside the enclosure, and the readings of the five comfs. It will be seen from the observations when A and B were interchanged that the slight variations were due to position. Figure 10

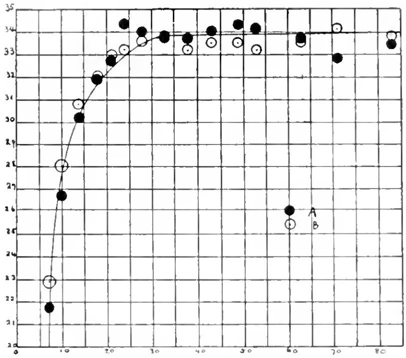


FIG. 10.—Comparative readings of two comfimeters, A and B, inside the same enclosure. Abscissas=time in minutes; ordinates=comf temperature in degrees centigrade.

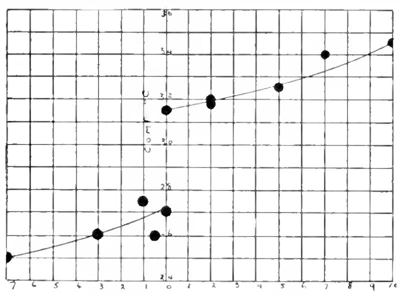


FIG. 11.—Showing rise of comfimeter reading with increase of voltage on lamp, and on a different day, fall of comf reading with decrease of voltage on lamp. Abscissas=percentage voltage variation; ordinates=comf temperature in degrees centigrade.

shows these observations plotted for A and B. The time during which they were taken was eighty minutes.

Observations were also taken within the screen in order to determine the effect of the variation of voltage, the temperature being approximately constant. From the results shown in Figure 11 it will be seen that a ± 6 per cent. voltage variation causes a difference of about 1.5° C. in comf reading.

Figure 10 also shows that about thirty minutes must be allowed for the comf to get in a steady state before the readings are taken.

Many observations taken at Hampstead confirm the conclusion drawn from the observations made at Toronto—namely, that in *still air* a linear relation exists between the kata and comf readings. Table 2 shows readings of both instruments taken at Hampstead, the comf being run off the ordinary lighting mains of the building. These mains are used for "lifts" and at times considerable variation in the voltage is experienced. As will be seen from Table 2, the observations were taken in various parts of different rooms. The equation obtained with these observations gives a relation between the cooling power H and the comf reading C, namely, $H = 16.8 - 0.35\ C$. The column H calculated gives the values obtained by using this equation to find H from the column C. These values give some idea of the variation that occurred.

It was found that no simple relation existed between the two instruments in a fast air current.

CONCLUSIONS

From the foregoing observations we may conclude that the comf is a reliable instrument for indicating whether the air conditions are satisfactory, provided the following precautions are taken:

1. That specially selected electric light bulbs (33-35 watts) are used.
2. That a practically steady main line voltage is used.
3. That each instrument is calibrated before use against a kata-thermometer.

TABLE 1.—COMPARISON OF READINGS OF FIVE COMFIMETERS INSIDE THE SAME ENCLOSURE

Time	Temperature		Comfimeter				
	Inside Enclosure	Outside Enclosure	A	B	C	D	E
min.	° *C.*	° *C.*					
6	16.2	--	21.7	22.9	21.7	22.0	21.8
10	16.7	--	26.7	28.0	28.0	27.1	27.6
14	17.0	14.8	30.2	30.8	31.0	30.3	30.2
18	17.0	14.8	31.9	32.1	32.5	31.7	31.8
21	17.0	14.7	32.7	33.0	32.8	32.6	32.3
24	17.2	15.0	34.3	33.2	33.1	33.2	32.8
28	17.3	15.0	34.0	33.6	33.5	33.8	33.4
33	17.4	15.0	33.7	33.8	33.8	33.8	33.7
38	17.6	15.3	33.7	33.2	33.9	33.6	33.5
43	17.8	15.3	34.0	33.5	34.2	34.0	33.7
49	17.8	15.3	34.3	33.5	34.3	34.2	33.9
53	17.8	15.5	34.1	33.2	32.3	33.8	33.9
63[1]	--	--	32.6	33.5	33.9	33.4	34.0
71	--	--	32.8	34.1	34.1	33.4	33.2
83	--	--	33.4	33.8	34.4	33.9	33.2

[1] The positions of A and B were interchanged here.

TABLE 2.—COMPARATIVE READINGS OF COMFIMETER AND KATA-THERMOMETER TAKEN IN VARIOUS PARTS OF DIFFERENT ROOMS

H Calculated	Comfimeter C	Kata H	Location of Instrument during Observations
6.5	29.56	6.81	2 feet from floor; no direct air current on instrument.
5.0	33.90	4.67	Instrument screened from direct draft; at waist level.
6.2	30.48	6.43	At side of room remote from open windows; at waist level.
6.1	30.70	6.20	At side of room remote from open door; on floor.
6.7	28.56	6.00	In middle of floor; window open 3 inches.
6.3	30.23	6.00	In middle of floor; window wide open.
5.4	32.70	5.40	Between two open doors, on bench 3 feet from floor.
6.0	30.96	6.00	Window and two doors open; on table 3 feet from floor.
6.1	30.70	5.70	On floor.
5.1	33.60	4.98	3 feet from floor.
4.6	34.90	4.70	" " " "
5.3	32.90	6.60	On floor.
5.0	33.90	6.80	" "
5.7	31.90	5.60	4 feet from floor.
3.9	36.90	4.70	" " " "
5.1	33.50	5.20	On floor.

Since the relation between the instruments is linear, observations should be taken at three different still air temperatures, the results should then be plotted and a straight line drawn through them; the equation of this line will then be the equation connecting the readings.

4. That the instrument is not used in a fast air current.

THE PHARMACOLOGY OF SOME PHENYLENEDIAMINES

(*Continued*)

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6. *Circulation*

The effects of the phenylenediamines on the circulation have not been previously studied. The results of this study indicate that they possess definite and marked actions on the circulation. A knowledge of these actions is essential in cases of acute and chronic poisoning and in cases of death from these compounds. The experiments consisted of intravenous injections in mammals; perfusion of turtles' hearts, perfusion of frogs' vessels, and treatment of strips of dog's ventricle and excised vessels with the compounds.

Injection Experiments.—Observations were made on sixteen dogs, two rabbits, and one cat. All injections were made intravenously. The compounds were used in their basic form and in the form of hydrochlorides, dissolved or suspended in 0.9 per cent. sodium chloride solution. The effects of the hydrochlorides were the same as those of the bases. The following functions were observed: pulse rate; mean blood pressure from the carotid artery recorded by a mercury manometer in the usual way; cardiac (ventricular) volume by means of the ball plethysmograph of Y. Henderson; and kidney volume from an oncometer. All records were made simultaneously on a slowly moving kymograph. At the same time the majority of animals were curarized and artificial respiration was maintained. This was necessary because of disturbances from convulsions which ensued promptly unless curare was injected. Small and large doses of the compounds were used, usually repeatedly in the same animal, and the analysis was carried as far as possible in order to ascertain the mechanism of action on the circulation, exclusive of the convulsant and other actions.

It may be stated at once that the results with the different phenylenediamines studied were qualitatively the same; they differed only quantitatively —that is, the meta and para compounds were weaker than the dimethyl and diethyl derivatives of para-phenylenediamine, while dimethyl-para-phenylenediamine was the strongest of all. Detailed descriptions are, therefore, omitted. Figure 2 illustrates the effects of metaphenylenediamine (the weakest compound), and Figure 3 the effects of dimethyl - para - phenylenediamine (the strongest compound) upon the circulation of dogs.

Immediately after the intravenous injection of moderate doses of 0.5 c.c. to 1 c.c. of 1 per cent. per kilo of the phenylenediamines there was a temporary fall of blood pressure, a decrease in the pulse rate, an increase in cardiac volume (diastolic tendency), and diminution in kidney volume. These effects lasted from one-half to one minute, and were followed by a complete recovery of all functions. One to two minutes later

there was a marked increase in pulse rate, with diminution in cardiac volume (systolic tendency), a rather marked and sustained rise of blood pressure lasting from ten to fifteen minutes, and an increase in kidney volume as long as the pulse rate and blood pressure remained increased. After fifteen to twenty minutes, all functions returned to their original conditions. These changes occurred with blood pressures below and above the shock level. With repeated small doses, and with very large single doses the depressor action predominated; the heart stopped in diastole and could not be revived by the usual resuscitative measures—direct electrical stimulation, increase in coronary pressure, cardiac massage, injections of epinephrine, digitalis, caffein, 6 per cent. acacia, and 0.9 per cent. sodium chloride. As a rule the heart appeared very dark. The auricles continued to beat, while the ventricles remained permanently inhibited. Occasionally ventricular fibrillation was observed at the end of the experiment. The effects were uninfluenced by previous section and atropinization of the vagi, and therefore were not due to depression of vagus function. The lowest effective intravenous dose of metaphenylenediamine was about 0.006 gm. per kilo; of the meta and para compounds about 0.017 gm. per kilo were required for definite and sustained action. The just effective dose of dimethyl-para-phenylenediamine was about 0.003 c.c. per kilo, of diethyl-para-phenylenediamine, 0.005 c.c. per kilo.

The effects of the phenylenediamines on the circulation resemble those of caffein and pituitary extract injected intravenously, and are mainly cardiac. The initial or immediate effects are due to direct cardiac depression, since all the changes are in the same direction—slowing of the pulse, cardiac dilatation, fall of blood pressure, and diminution in kidney volume. The depression from small doses is fleeting and is presumably

FIG. 2.—Effect of meta-phenylenediamine hydrochloride (0.0062 gm. per kilo injected intravenously) on the circulation of a curarized dog (11 kg.). Shows the moderate rise of blood pressure; initial slowing of pulse, and cardiac dilatation followed by increase in pulse rate and systolic tendency of the heart. Very little change in kidney volume. P=pulse rate. Time required for each stroke=five seconds.

due to reflex stimulation of the depressor nerve from local irritation of the endocardium by these compounds, which are powerful irritants for all tis-

sues. The depression cannot involve the vagus mechanism since it occurs after section and atropinization of the vagi. The later action is due to direct cardiac stimulation, since the changes are again tion unless the phenylenediamines possess specific renal vascular dilator effects. This does not seem to be the case, however, since all excised vessels, including the renal artery, are constricted.

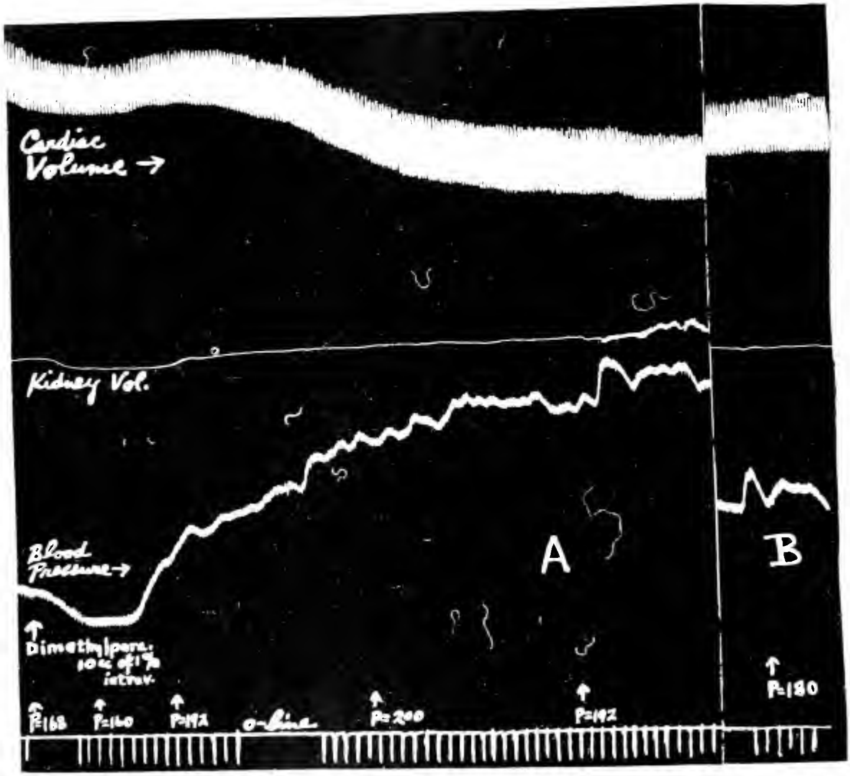

FIG. 3. Effect of dimethyl-para-phenylenediamine (0.008 gm. per kg. injected intravenously) on the circulation of a curarized dog (12.5 kg.). (A) shows the initial fall of blood pressure with diastolic tendency of the heart, and diminution in kidney volume, followed by marked and sustained rise in blood pressure, systolic tendency of the heart, and increase in kidney volume. (B) Recovery was not quite complete at the end of fifteen minutes after injection, remained the same at the end of thirty minutes when other injections were made. P=pulse rate. Time required for each stroke=five seconds.

in the same direction increase in pulse rate, systolic tendency of the heart, sustained rise in blood pressure, and increase in kidney volume. Since there is an increase in kidney volume, the effects cannot be due to sympathetic stimula- The pressor effects appear, therefore, to be due to direct cardiac stimulation. This supposition is further sustained by the augmentor effects observed on perfused turtles' hearts and strips of dog's ventricle. The toxic or final action con-

sists of direct cardiac depression and, finally, paralysis with death.

Turtles' Hearts.—The hearts of turtles were perfused *in situ* in the usual way, that is, an outflow cannula was placed in one of the aortas and an inflow cannula in a vena cava, and Ringer's solution to which the compounds were added in different concentrations was used. At the same time a record of the contractions was made on a slowly moving kymograph. The results on both untreated and atropinized hearts consisted of increase in tonus with some diminution in amplitude and acceleration of rate with concentrations of 1:20,000 to 1:10,000; and a fall of tonus, increase in amplitude, slowing of the pulse, and finally complete relaxation with standstill in the diastolic position with high concentrations (1:1,000). This is confirmative of the effects in mammals from the intravenous injection of small and large doses.

Dog's Ventricle.—Strips of ventricle from an atropinized dog's heart were immersed in warm, oxygenated Locke's solution, and contractions were recorded on a slowly moving kymograph; the ordinary arrangements for excised organs were used. The only effect observed was a gradual and sustained increase in tonus.

Peripheral Vessels of Frogs.—The vessels of frogs' extremities were perfused according to the Läwen-Trendelenburg technic. The effects of the dimethyl and diethyl derivatives of para-phenylenediamine were stronger, and are illustrated by Figure 4. The meta and para compounds were weaker, though qualitatively the effects were the same.

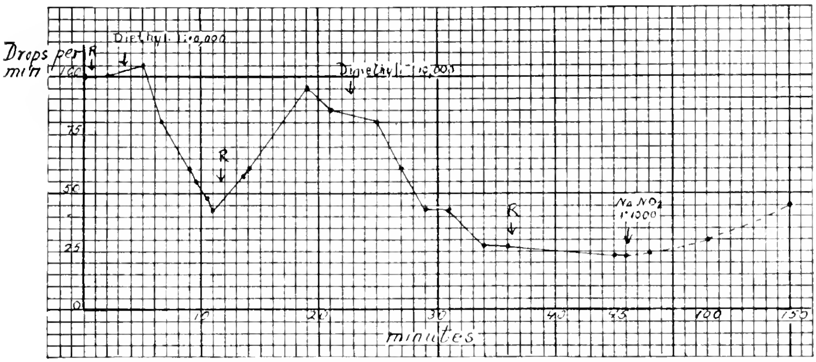

Fig. 4.—Constriction of blood vessels of frog's extremities by perfusion with diethyl-para-phenylenediamine (diethyl: base) and dimethyl-para-phenylenediamine (dimethyl: base). Constriction partly relieved by nitrite. R=frog's Ringer solution.

The effects consisted of constriction, and thus agreed with the effects on rings of excised arteries and aorta, which will be described later. The concentrations that were used ranged from 1:20,000 to 1:5,000, and the constrictions produced by these concentrations were removed by washing with plain Ringer's solution. As a rule the constrictions were antagonized by 0.1 per cent. nitrite. These results indicate that the rise of blood pressure observed after intravenous injection of small and moderate doses of

these compounds may be due at least in part, though not entirely, to a peripheral vasoconstriction. It will be recalled that the kidneys in injection experiments usually showed an increase in volume indicating a vascular relaxation, while excised renal artery was constricted. This simply means that the vessels in intact mammals play an uncertain, and presumably minor, rôle in the pressor action of the phenylenediamines, and that the main action depends upon the marked cardiac stimulation.

7. *Respiration*

The main effect of the phenylenediamines on respiration consisted of an increase in rate. This was observed after hypodermic and gastric administrations in intact dogs, cats, rabbits, white rats, and guinea-pigs. The wheezing, asthmatic respiration occurring in rabbits with edema of the tongue and neck from para-phenylenediamines was attributed by Erdmann and Vahlen, and Meissner to edema in the upper respiratory passages, including the glottis. The edema is undoubtedly a factor in this, since tracheotomy with the introduction of a cannula in the trachea gives marked relief. My experiments on bronchial tone indicate that there is also some bronchial constriction. This will be described in the next section.

Intravenous injection in dogs and cats, whose respiration was recorded by means of a tambour joined to a large T-tube in the trachea, showed that there was principally an increase in rate immediately after injection, followed by a slower respiration of greater depth. This occurred during the initial depressor action, and the respiratory change was the result of a brief period of anemia. When the blood pressure recovered and rose above the previous level, there was a recovery of the respiratory rate and volume to the previous condition. Further injections of the phenylenediamines usually resulted in tremors and convulsions with corresponding disturbances in respiration; as the convulsions subsided the respiration also recovered.

In rabbits, the respiratory rate and volume were reduced during the depressor action and increased when the blood pressure rose above the previous level. This augmentation in respiration continued until the level of blood pressure was again changed. With continued injections, convulsions supervened and markedly disturbed the respiration in the usual way. Fatal doses finally stopped the respiration altogether.

8. *Effects on Smooth Muscle*

The effects of phenylenediamines on smooth muscle are described for the first time in this paper. They were observed on excised and intact organs. The following organs were used: frog's stomach, esophagus, and bladder; intestine, uterus, and bladder of rabbits; pig's ureter; pupil of frog's excised eye, and intact eye of rabbit; intact bronchi of dog and guinea-pig; and excised aorta of rabbit and renal artery of dog. A great many experiments were made and the excised organs were treated in various ways for the purpose of analyzing the mechanism of the actions produced.

With excised intestine, uterus, bladder, ureter, and esophagus, longitudinal strips were made and suspended in warm, aerated Tyrode's solution, and records were made directly on a slowly moving kymograph. Frog's stomach was used in the form of ring preparations from the fundus. Aorta and renal

artery were also used in the form of rings. The enucleated frog's eyes were placed into little rings made from rubber tubing, and the solutions were applied directly. The experiments on bronchial tone will be described separately. It will be impossible to present records from all organs and under different conditions; instead, however, descriptive summaries with illustrative tracings of the actions on the uterus, bladder, and intestine will suffice. The differences in the various compounds will also be discussed briefly. Figures 5, 6, 7, 8, and 9 indicate typical effects with meta-phenylenediamine and para-phenylenediamine and the dimethyl and diethyl derivatives of para-phenylenediamine.

It was found that the phenylenediamines possessed definite and powerful actions on smooth muscle. Qualitatively, the responses with the different compounds studied were practically the same, except in the case of the pupil; they differed quantitatively, however. This difference will be discussed presently.

Intestine, Uterus, Stomach, Ureter, Bladder, and Excised Artery.—The action of the phenylenediamines on the excised stomach and intestine occurs in two stages. The first, or initial stage, occurs immediately after the application of the compounds. It is characterized by a fleeting depression of the tonus and amplitude of the contractions, and a slowing of the rate, contractions being barely perceptible with meta-phenylenediamine, definitely present with para-phenylenediamine and diethyl-para-phenylenediamine, and most pronounced with dimethyl-para-phenylenediamine. This depression usually lasts from one-half to one minute, but may last as long as five minutes if dimethyl-para-phenylenediamine is used. It was generally absent with strips of excised renal artery, aorta, uterus, ureter, and bladder. In other words, the temporary depres-

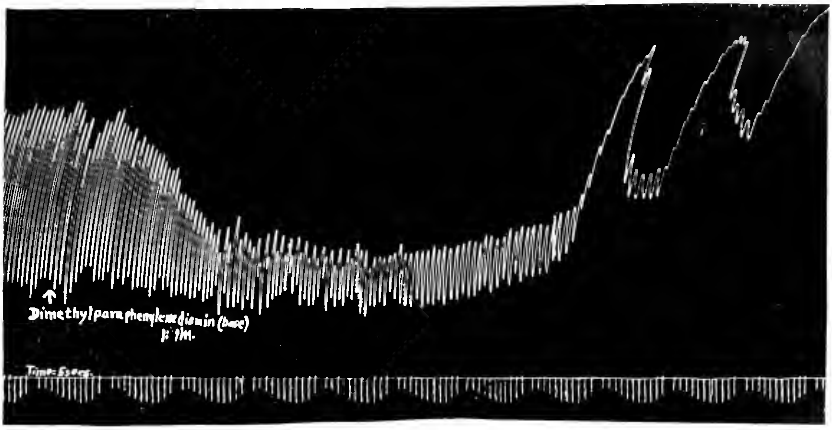

Fig. 5.—Effects of dimethyl-para-phenylenediamine (1:1,000 of base) on longitudinal strip of untreated rabbit's intestine in 50 c.c. of Tyrode's solution at 39° C. Time required for each stroke=five seconds. Shows depression for six minutes, followed by marked tonus augmentation which lasted for the next ten minutes, then gradually fell and was slightly lowered by atropine and epinephrine.

sion appeared to occur with those organs (intestine and stomach) which are innervated by inhibitory sympathetic fibers. The same occurred after preliminary treatment of these organs with apocodeine, which, according to some investigators, should exclude the sympathetic fibers from the site of action. The temporary, initial depression of the intestine and stomach was followed by a much more pronounced and sustained augmentor action on all the organs studied. This constituted the second or principal stage of action on the intestine and stomach, and the only action on the uterus, artery, ureter, and bladder (also bronchi). The eventual effect of high concentrations was depression and paralysis of all organs.

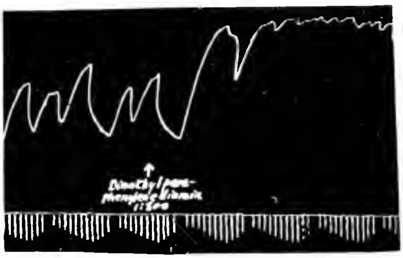

Fig. 6.—Effect of dimethyl-para-phenylenediamine (base, 1:800) on untreated pregnant uterus of cat in Tyrode's solution. Time required for each stroke=five seconds. Shows marked increase in tonus and rate of peristalsis which lasted for ten minutes.

The principal action of the phenylenediamines on organs containing smooth muscle consisted of a marked and lasting increase in tonus, with corresponding diminution in amplitude and a slight but variable increase in the rate of contractions. This action was most pronounced with dimethyl-para-phenylenediamine, and least (tonus augmentation) with meta-phenylenediamine. Meta-phenylenediamine caused principally an increase in amplitude of contractions of the intestine, uterus, stomach, and ureter, which lasted from five to ten minutes. There was no increase in tonus in any of the organs (except in the excised artery) and then it was barely detectable. Para-phenylenediamine produced a moderate increase in tonus of all organs, and diethyl-para-phenylenediamine caused a still further increase, while dimethyl-para-phenylenediamine was the most powerful of all. This gradation in tonus action of the phenylenediamines agrees in general with their toxicity and actions upon other functions—that is, meta-phenylenediamine is the least powerful, the para compound the next, then diethyl-para-phenylenediamine, and finally, dimethyl-para-phenylenediamine which is the most powerful. As would be expected, the diminution in amplitude and rate of contractions was proportional to the tonus increasing action of these compounds, and was least pronounced with meta-phenylenediamine and most pronounced with dimethyl-para-phenylenediamine.

The tonus augmentor action suggested that the mechanism of the action of para-phenylenediamine was on the muscle itself. This proved to be the case, since it occurred after exclusion of the ganglia and nerve endings by previous treatment of the organs with nicotine, atropine, and apocodeine, and also after inhibition of the intestine by epinephrine. Atropine and epinephrine only slightly depressed the marked increase in tonus of some preparations, and left others entirely unaffected. On the other hand, the increase in tonus was promptly abolished by chelidonine and papaverine, whose actions were on the muscle exclusive of nerve endings. It is concluded, therefore, that the mechanism of tonus augmentation in excised uterus, intestine, stomach, ureter, bladder, and

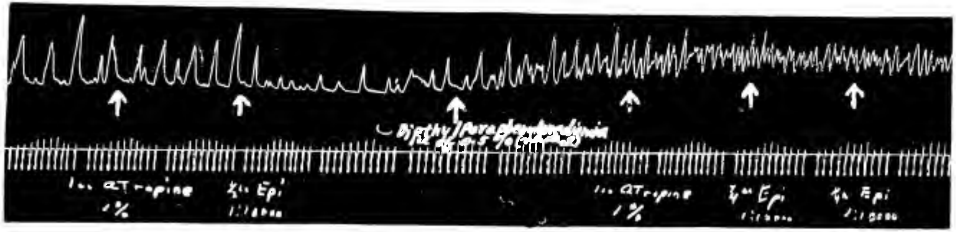

FIG. 7. Effect of diethyl-para-phenylenediamine (neutral, 1:30,000) on strip of guinea-pig's bladder previously treated with atropine and epinephrine. Time required for each stroke = five seconds. Shows increase in rate and tonus and diminution in amplitude uninfluenced by later treatment with atropine and epinephrine. Epi = epinephrine.

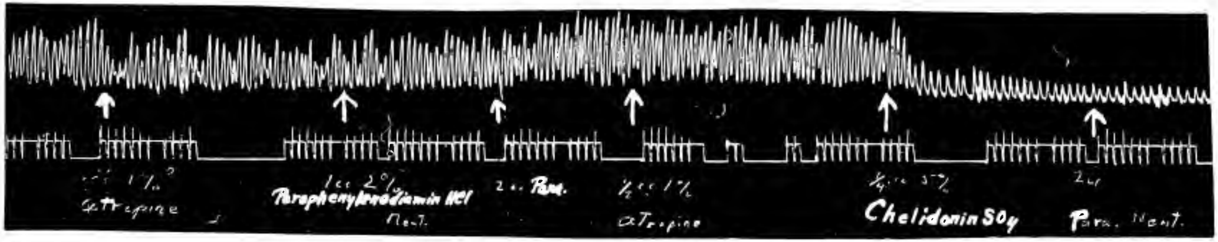

FIG. 8.—Effect of para-phenylenediamine hydrochloride (neutral, 1:8,000) on longitudinal strip of rabbit's intestine previously treated with atropine. Shows increase in tonus and amplitude of contractions, unaffected by treatment with atropine, relieved by chelidonine. Para-phenylenediamine ineffective after muscular depression by chelidonine. Time required for each stroke=five seconds.

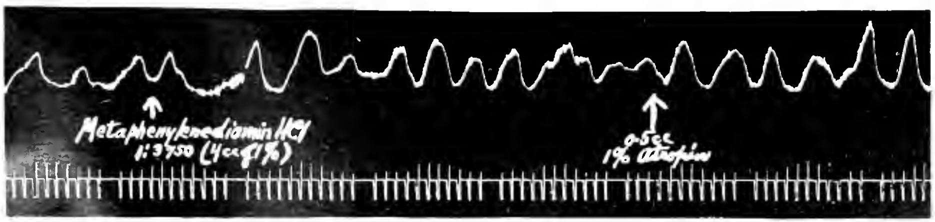

FIG. 9. Effect of meta-phenylenediamine hydrochloride (1:3,750) on pregnant uterus of rabbit. Shows slight increase in tonus and some increase in amplitude of contractions; unaffected by atropine. Time required for each stroke = five seconds.

artery by the phenylenediamines consists of direct stimulation of smooth muscle independently of nerve connections. This agrees with the stimulant action on cardiac musculature discussed in a previous section.

The effects on the pupil correspond to the very late and toxic actions on excised organs, that is, depression. These may now be described.

Pupil.—Enucleated frog's eyes and intact rabbit's eyes were used. Briefly summarized, the dimethyl and diethyl derivatives of para-phenylenediamine in 1 per cent. concentrations caused moderate relaxation of the pupils and rather marked corneal opacities in the majority of eight enucleated eyes. Irrigation with a solution of fluorescein showed permanent staining, indicating injury to the cornea. The dilated pupils of enucleated eyes were sluggishly responsive to light and unaffected by immersion into 1 per cent. solutions of pilocarpine, physostigmine, and barium chloride (also 10 per cent. barium solution), while the controls responded by constriction in the usual way. The pupils of two rabbits were only moderately relaxed, that is, from about 5.5 mm. (original diameter) to about 6.5 mm. (one-half hour after dimethyl-para-phenylenediamine had been applied). This effect was not antagonized by physostigmine. Conjunctivitis and corneal opacities were present from both compounds. These effects were interpreted as inflammatory injury to the eye, with moderate depression of the iris musculature. Similar pupillary and conjunctival changes were not seen in injected animals, until the convulsant stage when dilatation occurred from the asphyxia. Meta-phenylenediamine and para-phenylenediamine produced no noteworthy effects. Since the pupillary changes were rather inconstant and insignificant, the study was not pursued further. Troell* found the effects of para-phenylenediamine on the pupil of different species (dog, cat, rabbit, and guinea-pig) to be variable. Pupillodilatation was not always obtained, and it was uninfluenced by section of the cervical sympathetic ganglion and previous removal of the cervical ganglion. The exophthalmos and orbital edema also persisted after section of the sympathetic ganglion.

Bronchi.—A knowledge of the bronchial effects is of importance in explaining the wheezing and asthmatic respiration of animals injected with para-phenylenediamine, and the asthma of workers with fur dyes. It was indicated earlier in the paper that the dyspnea of animals with edema of the neck and face from para-phenylenediamine was due, in part, to swelling of the tongue and of the pharynx. There was probably also a bronchial element, since bronchoconstriction occurred after the injection of dimethyl-para-phenylenediamine and para-phenylenediamine. This was shown in five decerebrate dogs and seven intact guinea-pigs.

In the dogs, which were previously morphinized and decerebrated, changes in bronchial tone were registered from a Meltzer pleural cannula joined by rubber tubing to a tambour, which recorded the excursions on a slowly moving kymograph. Artificial respiration was used to produce the excursions which were reduced during bronchial constriction and increased as a result of relaxation. Figures 10 and 11 illustrate the effects of para-phenylenediamine and dimethyl-para-phenylenediamine on dog's bronchi.

*Troell, A.: Some Attempts to Produce Exophthalmos Experimentally. Arch. Int. Med., 1916, *17*, 382.

The intravenous injection of dimethyl-para-phenylenediamine and para-phenylenediamine was found to give definite bronchoconstriction, and this was promptly relieved by epinephrine and atropine. The doses which gave unmistakable effects—namely, 0.03 gm. per kilo of para-phenylenediamine and 0.0011 gm. per kilo of its dimethyl derivative—usually killed the animals. Smaller doses gave less pronounced effects. Meta-phenylenediamine in the dosage of 0.05 gm. per kilo injected intravenously produced no definite effects on intact bronchi.

FIG. 10.—Effect of para-phenylenediamine hydrochloride (neutral; 0.03 gm. per kilo intravenously) on bronchi of decerebrated dog (17.5 kg.). Constriction relieved by epinephrine intravenously. Time required for each stroke = five seconds.

The effects of intravenous injection of 0.05 to 0.5 gm. per kilo of dimethyl-para-phenylenediamine into three guinea-pigs consisted of marked increase in respiratory rate, dyspnea, restlessness, gasping, and convulsions; at the end of about ten minutes, there was a marked motor depression and the animals lay on their sides. At the end of fifteen minutes the animals were dead, the respiration having stopped before the heart. At autopsy the lungs were found to be congested, hemorrhagic, and definitely distended, and they floated on

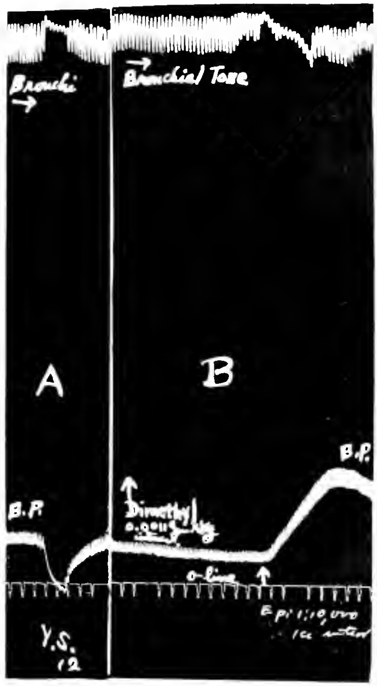

FIG. 11.—Effect of dimethyl-para-phenylenediamine (base, 0.0011 gm. per kilo intravenously) on bronchi of decerebrated dog (4.4 kg.). (A) Bronchoconstriction from stimulation of peripheral ends of both vagi with Harvard inductorium at 12 cm. (B) Bronchoconstriction from 0.0011 gm. per kilo of dimethyl-para-phenylenediamine independently of marked change in blood pressure, relieved by epinephrine (1 c.c. of 1:10,000 intravenously). Time required for each stroke = five seconds.

ether; these findings indicated that the lungs contained air from bronchoconstriction as in true anaphylactic shock and from certain anaphylactoid poisons demonstrated in previous studies. The hearts were not dilated.

The results with para-phenylenediamine and meta-phenylenediamine on guinea-pigs were not so well defined as those with dimethyl-para-phenylenediamine, although the majority of the animals used showed evidences of bronchoconstriction. Two guinea-pigs were injected intravenously with 0.042 gm. and 0.26 gm. per kilo of para-phenylenediamine hydrochloride, respectively. Anaphylactoid symptoms were indicated in both animals by restlessness, shivering, jerky movements, increased respiratory rate, and dyspnea. At the end of half an hour both animals were killed. At autopsy, the lungs of the animal which received 0.042 gm. per kilo were pale and partially distended and floated on ether, while the lungs of the animal which received 0.26 gm. per kilo were collapsed, and sank in ether. The two guinea-pigs which were injected with meta-phenylenediamine hydrochloride (0.11 gm. and 0.3 gm. per kilo, respectively) showed moderate anaphylactoid symptoms, consisting of moderate dyspnea and some increase in respiratory rate. The effects were not fatal and the animals were killed at the end of half an hour. At autopsy the lungs of both animals were distended, hemorrhagic, and lighter than ether. From the results of injection experiments, together with the results of experiments on guinea-pigs, it appears justifiable to conclude that the phenylenediamines studied cause constriction of bronchi, and that the effects are most marked with dimethyl-para-phenylenediamine and least marked with meta-phenylenediamine.

9. *Skeletal Muscle*

Thus far it has been seen that the phenylenediamines are powerful stimulants of smooth and cardiac muscles. In order to make the study more complete, observations were made on the skeletal muscle of frogs. Two sets of experiments were made. In one set, the phenylenediamines (in the form of hydrochlorides and of bases) were applied directly to frog's gastrocnemius muscle in Ringer's solution, and the contractions were recorded on a slowly moving kymograph. The results consisted of an increase in tonus, with concentrations of 1:10,000, and depression by further addition of solutions of 1:1,000 strength. In the other set of experiments, frog's gastrocnemii were stimulated with minimal break stimuli before and after immersion of the muscles in solutions of different strengths. The results invariably showed an increase in contractility with solutions of 1:10,000 of the different phenylenediamines, and depression with higher concentrations (1 per cent.). These results agree, therefore, with the actions on other muscles.

10. *Excretion*

This was observed in animals and in three human subjects. The gastric and hypodermic administration of para-phenylenediamine to rabbits, and of dimethyl-para-phenylenediamine to rabbits and dogs caused marked discoloration of the urine. The urines appeared dark brown and their color was intensified by the addition of hydrogen peroxide and ferric chloride. This means that these compounds were excreted as such in part, and that the darkening of the urine as a result of the addition of oxidizing agents was due to quinonedi-

imine. Whether or not quinonediimine was formed in the body is not definitely known, although its presence in urine was suggested by the dark color. Erdmann and Vahlen laid stress on this point, believing that the formation of quinonediimine in the body was responsible for the irritation and edemas produced by these compounds when administered systemically.

Subjects W. C., P. J. H., and D. each took 0.5 gm. of meta-phenylenediamine hydrochloride (lentin) by mouth and collected urinary specimens at the end of fifteen minutes, one hour, four hours, and twelve hours. Griess' meta-phenylenediamine-nitrite reaction was applied to the urines. This was done by rendering 20 c.c. of urine alkaline with 5 per cent. ammonium hydroxide; then the mixtures were warmed and acidified with 10 per cent. sulphuric acid, and a few drops of 1 per cent. sodium nitrite were added. The presence of meta-phenylenediamine was indicated by the development of an intense yellowish brown to deep brown (Bismarck brown) color. When the test was applied in this way to all urines, only the four-hour and twelve-hour specimens in two of the subjects (W. C. and P. J. H.) gave unmistakable brownish colorations, indicating the presence of meta-phenylenediamine. The fact that both of these specimens were darker in color than the fifteen-minute and one-hour specimens of these subjects indicated the presence in the urines of the oxidation product, quinonediimine. The urines of subject D. were light in color and gave negative results with Griess' reaction. Apparently the meta-phenylenediamine was not absorbed, or else the urines were too dilute. None of the subjects experienced any symptoms after taking the drug. Under the name of lentin, meta-phenylenediamine has been advocated as an antidiarrheal remedy. When the facts, namely, that it increases the peristalsis of excised intestine, that it is not astringent, and that it is absorbed to some extent (as indicated by its excretion), are considered, it is difficult to understand the basis for its alleged antidiarrheal action.

V. Discussion

The results of this study indicate that the phenylenediamines are definitely toxic compounds. Dimethyl-para-phenylenediamine was found to be the most toxic, and meta-phenylenediamine probably the least toxic, although in some animals it appeared to be about as toxic as para-phenylenediamine. Diethyl-para-phenylenediamine is about as toxic as the para compound. A summary of the principal actions of the phenylenediamines studied is presented in Table 2, and requires no further discussion. The rapid development of symptoms of toxicity after dermal application is a unique feature among the actions of dimethyl-para-phenylenediamine and diethyl-para-phenylenediamine, the fatal dosage from skin being practically no greater than that by hypodermic administration. This indicates unusual rapidity of absorption and is connected with the marked volatility and lipoid solubility of these bases. On the assumption that the absorption from human skin is about the same as that from rabbit's skin, it is estimated that about a teaspoonful of dimethyl-para-phenylenediamine held on the palm of the hand would constitute a fatal dose for an adult man of 60 kilos body-weight. This is of importance in poisoning from the handling of the compound itself and of articles dyed and treated with it in vari-

ous industries. It means that effects on the higher functions are possible from skin absorption. Barring individual differences, dimethyl-para-phenylenediamine is one of the most efficient skin irritants known, though probably not surpassing dichlorethylsulphide (mustard gas) whose actions it does not modify sufficiently to be of therapeutic importance in the treatment of burns and other lesions. Its toxicity is against its use for this purpose. Furthermore, these compounds, in basic form, are volatile, and their vapors cause death when inhaled by animals. They also act as irritants to the respiratory tract, causing and rendering it susceptible to rhinitis, pharyngitis, bronchitis, and even pneumonia if enough is inhaled.

The salts are non-irritant for skin, and indicate a method of treatment of the lesions produced by the bases. Accordingly, acetic acid, which can be used without injury in fairly high concentrations (10 per cent. and higher), was found to be efficient for prevention of lesions before marked itching occurred.

Under the conditions of the experiments, para-phenylenediamine and meta-phenylenediamine were not sufficiently irritant to the skin of animals and of man to require further discussion. This might be quite different with repeated applications or with applications applied to the injured skin, and in instances of chronic poisoning from the use of para-phenylenediamine in hair dyes and in dyed furs in the fur industry.

All the phenylenediamines produce definite systemic effects after absorption. They stimulate the circulation, respiration, and smooth muscle of excised organs, and cause bronchoconstriction. Asthma and local inflammations of the respiratory tract among workers in the fur dyeing industry are commonly reported. The claim that sensitization from articles dyed or treated with phenylenediamine and its oxidation product will explain the symptomatology on the basis of anaphylaxis, was found to be untenable. The phenylenediamines, and presumably also quinonediimine, irritate directly through their inherent chemical properties and do not act through other mechanisms. The local irritation occurs independently of precipitation in the tissues. It is more probable that direct bronchial stimulation and irritation by para-phenylenediamine, rather than anaphylaxis, are the cause of the asthma of fur dyers. Disturbances of the circulation and alimentary tract from the phenylenediamines under industrial conditions are also conceivable. Workmen should, therefore, be protected against these compounds in industry, and the use of para-phenylenediamine in hair dyes and other cosmetics should be prohibited.

The production of facial and cervical edemas by para-phenylenediamine, and of hydrothorax and possibly hydroperitoneum by meta-phenylenediamine is of interest mainly to experimental pathology and pharmacology. Facial and cervical edemas in human individuals have been reported in poisoning from the use of hair dyes containing para-phenylenediamine.

Therapeutically, the phenylenediamines are of no significance. A scientific basis for the alleged antidiarrheal and antidysenteric properties of meta-phenylenediamine (lentin) is lacking, and its use is unwarranted. Experimental evidence indicates that it would increase peristalsis, if anything, and that it might be harmful otherwise (by the production of effusions).

VI. Conclusions

1. The phenylenediamines, which are used extensively in industry, arts, and science, are definitely toxic compounds and possess a variety of striking pharmacological actions.

TABLE 2.—SUMMARY OF IMPORTANT ACTIONS OF SOME PHENYLENEDIAMINES

Compounds Studied (Arranged in Descending Order of Toxicity)	Skin Irritation and Vesication	Circulation	Respiration	Temperature	Smooth Muscle of Excised Organs[1]	Convulsant Action	Production of Systemic Edema and Exudates	Vapor Toxicity
Dimethyl-para-phenylenediamine	positive	marked stimulation[2]	marked stimulation	lowered	fleeting depression followed by marked stimulation (chiefly tonus)	positive	negative	positive
Diethyl-para-phenylenediamine	"	less marked stimulation	the same	"	the same	"	"	negative
Para-phenylenediamine	negative	moderate stimulation	moderate stimulation	"	moderate stimulation (chiefly amplitude)	" (less pronounced)	positive as to edemas	"
Meta-phenylenediamine	"	the same	the same	"	the same	" (least pronounced)	positive as to exudates	"

[1] Intestine, uterus, bladder, stomach, ureter, aorta, pupil (also intact pupil) and intact bronchi.

[2] Increase in pulse rate, rise in blood pressure, systolic tendency of heart and increase in kidney volume. Increased rate and systolic tendency of excised turtle heart and increased tone of dog's ventricle (strips).

2. According to the minimal fatal dosage in several species, the compounds that were studied arrange themselves in descending order of toxicity as follows: dimethyl-para-phenylenediamine, diethyl-para-phenylenediamine, para-phenylenediamine, and meta-phenylenediamine.

3. Because of their volatility and marked lipoid solubility, dimethyl-para-phenylenediamine and diethyl-para-phenylenediamine, in basic form, are absorbed from the unbroken skin of rabbits, and cause systemic symptoms of poisoning and death. The vapors of dimethyl - para - phenylenediamine are toxic to animals.

4. Locally, dimethyl-para-phenylenediamine and diethyl-para-phenylenediamine, in basic form, are marked irritants, and cause dermatitis with marked edema of the skin of rabbits and dogs, and dermatitis and vesication on human skin. Their salts are non-irritant. Treatment of skin with acetic acid before

itching develops prevents the burns. Meta-phenylenediamine and para-phenylenediamine are very slightly, or not at all, irritant in acute experiments, but the result might be different with repeated applications or with applications on broken skin. Gastric administration causes nausea and vomiting in cats and dogs.

5. Systemically, all the phenylenediamines cause definite symptoms—namely, stimulation of the circulation and respiration, fall of body temperature, tremors, increased reflex excitability, convulsions, coma, and death.

6. Intravenously, the circulatory effects are characterized by initial fleeting depression, followed by marked stimulation of cardiac musculature with corresponding changes in pulse rate, cardiac volume, blood pressure, and kidney volume.

7. The convulsions in mammals are due to the compounds themselves. In frogs, a narcotic or morphine-like action occurs.

8. Besides these changes, the hypodermic and gastric administrations of para-phenylenediamine produce in rabbits a peculiar, specific edema of the face, nose, tongue, conjunctiva, and neck, while meta-phenylenediamine causes hydrothorax, and possibly hydroperitoneum. The dosage necessary to produce this effect, and the response of rabbits are variable. White rats failed to respond with edema and exudate formation to the meta and para compounds; and rabbits, white rats, cats, and dogs failed to respond to dimethyl-para-phenylenediamine and diethyl para-phenylenediamine, because of the marked toxicity of these compounds.

9. The production of edemas and exudates by these compounds is of interest to experimental pathology and pharmacology. The mechanism by which these lesions are produced remains unsolved.[1]

10. The principal action of the phenylenediamines on smooth muscle of excised organs (intestine, stomach, esophagus, uterus, ureter, bladder, aorta, and renal artery) consists of stimulation independently of nerve connections, and is most pronounced (especially tonus) with dimethyl-para-phenylenediamine and least pronounced with meta-phenylenediamine. The pupils of enucleated and intact eyes are dilated, and intact bronchi are constricted.

11. The asthma and respiratory symptoms of workers in the fur-dye industry, in which para-phenylenediamine is used, are due, therefore, to direct irritation and bronchial stimulation rather than to anaphylaxis.

12. The results of this investigation indicate that workmen should be protected against the phenylenediamines used in various industries, and that the use of para-phenylenediamine in hair dyes and cosmetics should be prohibited.

13. Therapeutically, the phenylenediamines are of no importance, and a scientific basis for the alleged benefits of meta-phenylenediamine (lentin) as an antidiarrheal and antidysenteric remedy is lacking.

[1] While this paper was in galley proof, a paper entitled, "The Edema of Paraphenylenediamin," by O. S. Gibbs, appeared in the *Journal of Pharmacology and Experimental Therapeutics*, 1922, *20*, 221. Gibbs leaves the mechanism of the edema (in cats) unsolved, although he suggests changes in blood colloids as being fundamentally concerned. His evidences for this are not convincing.

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CARBON MONOXIDE ASPHYXIA: THE PROBLEM OF RESUSCITATION*

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INTRODUCTION

THE problem of resuscitation from carbon monoxide asphyxia possesses far greater complexity than is offered in the case of resuscitation either from drowning or from electric shock. In these latter cases, as Henderson and Haggard (1) have pointed out in the first report of this Commission, the patient is practically saved when respiration has been restored. There is little or no question of effects which may express themselves hours or even days afterwards. Furthermore, these two common types of accident are essentially acute. In drowning, for example, the heart may be experiencing the effects of acute asphyxia at the moment when artificial respiration is started, but it has not been subjected to a prolonged period of gradually developing oxygen lack, as may readily be the case in carbon monoxide poisoning. Another important element in carbon monoxide asphyxia is found in the fact that gassed patients may pass through a prolonged period of unconsciousness both before and after natural respiration has been restored. While in drowning there is, of course, aspiration of water into the air passages, the water which is not emptied out during the measures utilized for resuscitation is usually absorbed rapidly and causes no damage. In carbon monoxide asphyxia, on the other hand, there is considerable evidence of the existence of pulmonary congestion and of overproduction of fluid in the lungs and the bronchial tree, and the presence of this fluid must be kept in mind when one considers the best sort of artificial respiration to employ.

Before making an actual examination of artificial respiration, the authors have felt it wise, first, to obtain knowl-

*Report II of the Commission on Resuscitation from Carbon Monoxide Asphyxia. Personnel of the Commission: Cecil K. Drinker, M.D., Associate Professor of Applied Physiology, Harvard Medical School, Chairman; Walter B. Cannon, M.D., Professor of Physiology, Harvard Medical School; David L. Edsall, M.D., Dean of the Harvard Medical School, and Professor of Clinical Medicine, Harvard Medical School; Howard W. Haggard, M.D., Instructor in Applied Physiology, Yale University; Lawrence J. Henderson, M.D., Professor of Biological Chemistry, Harvard Medical School; Yandell Henderson, Ph.D., Professor of Applied Physiology, Yale University; Francis W. Peabody, M.D., Professor of Medicine, Harvard Medical School; Royd R. Sayers, M.D., Chief Surgeon, United States Bureau of Mines, Washington, D.C.; and Charles B. Scott, Bureau of Safety, American Gas Association. Received for publication Jan. 15, 1923.

edge of the current practice in resuscitation in the gas-producing industry of the country and, secondly, to examine more thoroughly than has been done in the past the clinical course of gassed patients who have received hospital treatment.

Section I. Present Practice in Resuscitation from Poisoning by Illuminating Gas

After communicating with Mr. Oscar H. Fogg, Secretary-Manager of the American Gas Association, we sent to a group of seventeen large gas producers an explanatory letter and the following questionnaire:

Questionnaire

1. What is your present organization for dealing with gassed cases?
2. How have the individuals in charge of this work been trained?
3. Do you issue any general instructions to foremen, etc., relative to artificial respiration?
4. What equipment do you provide for your resuscitation team? Why has this equipment been chosen?
5. If possible, forward records of all cases treated for gas poisoning by agents of your company during the past five years. It is important that these records include notes as to whether the patient was breathing when treatment began; how long the treatment continued; any details available as to the immediate and future condition of patients who recovered.
6. Forward any comments upon the resuscitation problem which have not been covered by the preceding questions and which you believe may be of service to the committee.

The following firms received this request for information:

1. The Consolidated Gas Electric Light and Power Company of Baltimore.
2. The Boston Consolidated Gas Company.
3. The Brooklyn Union Gas Company.
4. The Peoples Gas Light and Coke Company of Chicago.
5. The Denver Gas and Electric Light Company.
6. The Detroit City Gas Company.
7. The Georgia Railway and Power Company.
8. The Southern California Gas Company.
9. The Milwaukee Gas Light Company.
10. The New Haven Gas Light Company.
11. The Providence Gas Company.
12. The Public Service Gas Company of Newark.
13. The Consolidated Gas Company of New York.
14. The United Gas Improvement Company of Philadelphia.
15. Portland Gas and Coke Company.
16. The Rochester Gas and Electric Corporation.
17. The Laclede Gas Light Company of St. Louis.

These widely scattered organizations may be considered to represent the experience of gas producers in this country. All except one replied, and usually in great detail.

In summarizing the answers received, it is possible to treat the questions together. In all cases, one is impressed by the effort that has been made to place resuscitation upon a practical basis. In most instances this work is allotted to carefully trained rescue crews on duty in shifts so that all calls can receive immediate attention. Occasionally larger groups of responsible employees, headed by a superintendent and extending down through sub-foremen, have received first-aid instruction, the size of the group ensuring the availability at all times of someone competent to render assistance.

If, now, we systematize the information received in regard to the methods of resuscitation actually used, we find that in all cases the Schäfer, or prone pressure, method of artificial respiration is taught. Whether or not the chief reliance is placed upon this method is another matter. Table 1 summarizes the situation existing prior to the publica-

tion of the work of the present Commission.

Prone Pressure Group

Seven out of sixteen firms rely upon manual methods to the exclusion of apparatus. The statements made are of interest:

Chicago.—"The only equipment provided is an oxygen tank to use with the artificial respiration in case it is needed. This practice has been established because a study of the pulmotor reports used by this office prior to 1915 did not show satisfactory results."

Atlanta.—"We have a pulmotor but have discarded use of this. We use the prone pressure method."

Newark.—"The Public Service Gas Company has become satisfied that the Prone Pressure Method of Resuscitation is superior to any requiring mechanical appliances."

Portland.—"We have used the Pulmotor in a limited number of cases but our experience has not been sufficient to arrive at any definite opinion as to its merits or demerits. We are inclined to believe, however, judging from our experience, that the Prone method of resuscitation is superior to the use of the Pulmotor or other similar appliances on the market."

St. Louis.—"We formerly had a number of lungmotors, and still have them but are not using them. We have discarded their use due to the delay which usually follows in the lungmotor reaching the scene of the accident promptly, and which is so essential to rescue work. We are thoroughly convinced the Prone Pressure Method of resuscitation is the best method, for the reason fellow workmen can, without any delay, or without waiting for mechanical equipment, immediately start to work on the victim. The use of mechanical equipment requires a trained operator, and also requires the equipment itself be kept in a 100 per cent. condition at all times, and we are advocating the use of the Prone Pressure Method in cases of electric shock, as well as gassed cases."

Milwaukee.—"This company does not maintain a rescue squad though we do own and keep at convenient locations two pulmotors and three lungmotors. We, however, have never used any one of these machines in the several years that they have been in our possession. . . . There is so much conflicting testimony that we have been very

TABLE 1.—SUMMARY OF THE IMMEDIATE METHOD OF RESUSCITATION EMPLOYED BY A GROUP OF REPRESENTATIVE GAS PRODUCERS IN THE UNITED STATES

Prone Pressure Method (No Apparatus Used)	Lungmotor	Pulmotor
1. The Peoples Gas Light and Coke Company of Chicago	1. The Denver Gas and Electric Light Company	1. The Consolidated Gas Electric Light and Power Company of Baltimore
2. The Georgia Railway and Power Company	2. The Detroit City Gas Company	2. The Boston Consolidated Gas Company
3. The Milwaukee Gas Light Company[1]	3. The New Haven Gas Light Company	3. The Brooklyn Union Gas Company
4. The Public Service Gas Company of Newark		4. The Denver Gas and Electric Light Company
5. The Portland Gas and Coke Company		5. The New Haven Gas Light Company
6. The Laclede Gas Light Company of St. Louis		6. The Providence Gas Company
7. The Southern California Gas Company[2]		7. The Consolidated Gas Company of New York
		8. The United Gas Improvement Company of Philadelphia

[1] Owns both lungmotor and pulmotor but has never used them.

[2] Possesses pulmotor but has never used it.

loath to put the equipment into use on our own responsibility."

Lungmotor Group

Denver.—"In all our plants, general office, and in the safety department, we have both the pulmotor and lungmotor, oxygen tanks, and special breathing devices. Our men are instructed to never use them except as a *last resort*. Our teams and men have been taught the prone pressure method and I fully believe that if this method fails to revive a patient, all the artificial devices will be of no avail. I have no faith in the lungmotor or pulmotor, but for the moral effect I feel that it is wise to have them."

Detroit.—"The Detroit City Gas Company makes use of rescue crews, the members of which are trained in the company's School of Instruction in the mechanical handling of gassed cases and in the providing of proper ventilation, etc.; also, in the use of the Schäfer method of artificial respiration, the use of the lungmotor and its accessories, in the administration of stimulants, and in diagnosing the effects of treatments administered. . . . We believe that the lungmotor is very efficient as a means of resuscitation. Over a period of two years, not a single case has been lost where life was found to exist when we took charge of the subject."

Beginning in January, 1921, this company has kept a record of the cases of gas poisoning which it has cared for. The list consists of fifty-six cases. Table 2 indicates the character of the respiration in these patients when relief measures were instituted. In two cases character of breathing was not given. Of the cases not breathing when first seen, all three were pronounced dead by a physician either immediately or within thirty minutes.

Table 3 shows at a glance the treatment given under the varied conditions of respiration which existed when the patients were first seen. If gassed patients are not breathing, they are dead or very nearly so, and the wisdom of relying upon the prone pressure method of artificial respiration without the necessity of waiting for instruments is at once apparent. The gassed patient who has stopped breathing is in even worse condition than the patient suffering from electric shock, since he has been subjected to a considerable period of anoxemia prior to actual cessation of respiration, and his heart is in no condition to stand further strain. Table 3,

TABLE 2.—CHARACTER OF RESPIRATION IN FIFTY-FOUR CASES OF GAS POISONING WHEN FOUND BY RELIEF CREWS OF THE DETROIT CITY GAS COMPANY

Not Breathing	Slight or Difficult Breathing	Excessive Breathing	Normal Breathing
3	14	21	16

however, brings out the fact that most patients poisoned by illuminating gas are breathing when first seen. No patient who breathes naturally needs or should be given artificial respiration either by apparatus or manually. Apparatus is likely to oppose the natural movements rather than to assist them, which is not the case with the manual method. But even this method is contraindicated when the subject is breathing spontaneously. The object to be aimed at is the displacement of carbon monoxide from the blood through the mass action of increased oxygen concentration in the lungs.

The wisdom of the oxygen carbon-dioxide inhalations recommended by Henderson and Haggard in the first report of the committee is more than ever clear. The best chance for recovery of the fourteen patients breathing slightly or with difficulty is in natural or in rather deep breathing, with opportunity to get plenty of oxygen. Such a situation

is provided with greater certainty by means of oxygen carbon-dioxide inhalations than by any measures entailing positive pressure ventilation.

A final point of interest is found in the number of patients who were breathing either excessively or naturally. These are cases of early or slight poisoning, yet it will be seen that the lungmotor has been used in six of them, a procedure which has no logical justification. The existence of a period of excessive breathing is an interesting confirmation of the experiments of Henderson and Haggard presented in the first report of the Commission.

In twenty-one of the fifty-six Detroit cases the patients were unconscious when first seen, and certain of them were sent to hospitals. In four cases the breathing is described as *hard*, which means obstructed. All of these points are of importance to us. The unconscious patient, even though he may be able to breathe normally, is less able than is the conscious individual to protect himself against the possibility that mucus, saliva, vomitus, or blood may pass down the trachea and into the lungs. The frequency of pulmonary complications in gassed cases forms the second part of this report and the possible relation of positive ventilation to such complications is discussed.

New Haven.—The New Haven Gas Light Company instructs a fairly large group of employees in the prone pressure method of resuscitation and also possesses both a pulmotor and a lungmotor. In regard to the condition of gassed cases when first seen, the following statement is made: "During twelve years' active service with gangs of men engaged in laying gas mains and services, there have been probably only five or six cases where the patient did not recover consciousness in less than five minutes. The largest number of cases (numbering possibly two hundred) have returned to consciousness in from one to three minutes. My understanding of this fact is that the patient has been more suffocated by the absence of oxygen than poisoned by the carbon monoxide of the manufactured gas, and as soon as removed from a gaseous atmosphere, if respiration had not been entirely suspended, natural breathing was sufficient to return the patient to normal condition."

The reasons given for utilization of the pulmotor and the lungmotor are: "The pulmotor was chosen because it provided an apparatus to use in extreme cases where respiration had practically been suspended, that would draw out of the lungs what air or gas was in them, and would put into the lungs air that had been enriched with additional oxygen. It seemed to function under a pressure that (to the layman at least) was not great enough to destroy the lung tissues. Later when the lungmotor was developed, it was purchased as an additional equipment, that probably was better than the pulmotor on the ground that the quantity put into and taken out of the lungs could be increased or decreased (within reasonable limits) to suit the lungs of the patient."

TABLE 3.—CHARACTER OF TREATMENT IN FIFTY-FOUR CASES OF GAS POISONING REPORTED BY DETROIT CITY GAS COMPANY

Not Breathing	Slight or Difficult Breathing	Excessive Breathing	Normal Breathing
3	14	21	16
Lungmotor in 2.	Lungmotor in 13. Oxygen inhalations in 1.	Lungmotor in 4. Oxygen inhalations in 17.	Lungmotor in 2. Oxygen inhalations in 14.

The Pulmotor Group

Eight firms possess and use the pulmotor. Upon reading their experiences with the instrument, one obtains the impression that the original purchases were made some time ago when the mechanical ingenuity of the apparatus, coupled with a most effective advertising campaign, seem to have recommended the pulmotor very widely; and that

its use at the present time depends largely upon the demand of the public for the instrument—a demand which, in turn, is fostered by the willingness of the press to print any item of news to which the word *pulmotor* is attached. None of the material received contained data demonstrating an efficiency for the pulmotor unattainable by the simple manual method of artificial respiration. The following statement will serve to summarize the general attitude of pulmotor users toward the subject.

Philadelphia.—"We consider the Schäfer Manual Prone Pressure Method as now taught superior to any method involving mechanical apparatus, but have not had any experience to indicate that the latter should be entirely done away with."

Summary of Section I

The first section of the report may be summarized as follows:

1. Gas companies throughout the country are making earnest endeavor to provide the best means of resuscitation known to them.

2. Seven firms employ the Schäfer prone pressure method alone. Three employ the lungmotor and eight the pulmotor (two of these firms using both instruments). Of those using the prone pressure method, three have discarded mechanical devices for artificial respiration.

3. The experience of the Detroit City Gas Company indicates that in most cases of gas poisoning the patients are breathing when first seen and that a large percentage are unconscious.

4. These facts indicate the utility of the oxygen carbon-dioxide inhalations recommended by Henderson and Haggard in the first report of the Commission. This method of treatment induces deeper breathing and avoids the possibility of forcing fluid into the lungs and so giving a basis for a possible bronchopneumonia. Inhalation of oxygen alone has rather wide employment among the gas companies and can be commended.

5. The fact, as indicated by the Detroit City Gas Company records, that the most severely gassed patients are usually taken to a hospital indicates the necessity for an examination of hospital records in order to get data upon the final outcome of gassing and, in particular, upon the frequency of pulmonary complications—a point which bears upon the type of artificial respiration to be advised.

Section II. The Eventual Course of Patients Poisoned by Carbon Monoxide

Seriously gassed patients do not present immediate problems in regard to resuscitation when they finally arrive at a hospital. At this time they have practically always begun to breathe, and they are brought in for care during recovery from a severe experience. It happens, however, that the subsequent course of such cases has a possible relation to the type of resuscitative treatment applied by rescue squads when the patients are first seen.

The literature upon carbon monoxide poisoning contains many references to pneumonia as a sequel, and to the existence of râles in the chest and of pulmonary edema as immediate accompaniments of severe gassing, and especially of gassing which has occurred slowly. There are, however, no statistical data upon the frequency with which excess moisture is found in the respiratory passages and deep in the lungs of patients poisoned by gas. If it should prove to be the case that gas poisoning is frequently accompanied by moisture in the

respiratory passages, the evidence might have direct bearing upon the type of artificial respiration to be employed when the patients are first seen. An examination of the literature has not disclosed experiments upon the question whether positive ventilation can force infected material down the trachea and into the depths of the lungs. If this should be the case, and it is a subject for experimentation by the Commission at the present time, the bearing upon the use of apparatus such as the pulmotor and lungmotor is obvious. Both of these instruments drive air into the lungs and whether they operate with a sufficient degree of force to carry infected material into the alveoli to form eventual patches of bronchopneumonia, merits investigation.

Examination of the literature discloses the fact that cardiac failure and particularly failure of the right side of the heart, accompanied by pulmonary edema, is frequently the cause of death or of serious danger in gassed patients. If apparatus for artificial respiration is used which is capable of increasing intrapulmonic air pressure to an inordinate degree, it may well be possible at the height of the inspiratory stroke to compress the alveolar capillaries and thus raise the blood pressure in the pulmonary circulation. The unfortunate effect of such a situation upon a right ventricle already in a precarious condition is obvious. Fortunately, this objection to positive ventilation in illuminating gas poisoning is one which can be answered by experimentation upon animals, and animal experiments in which are utilized familiar types of artificial respiration apparatus, such as the lungmotor and the pulmotor, are, therefore, being undertaken and will be made public in a later report.

The literature upon gas poisoning lacks statistical data upon the frequency of bronchopneumonia as a sequel and upon the existence of lung findings in general. Believing the best source of such data to be hospital records, we have made an examination of the records of gassed patients in nine hospitals in Boston, New York, and Philadelphia. The total number of cases covered in this investigation is 860. The distribution, together with the years covered, is given in Table 4. The data from the three cities were gathered by different individuals and the points covered were kept as simple as possible. The hospitals providing the material were:

Boston.—Boston City Hospital.

New York.—Bellevue Hospital.

Philadelphia. — Pennsylvania Hospital; University Hospital; Episcopal Hospital; Presbyterian Hospital; Hahnemann Hospital; Jefferson Hospital; Polyclinic Hospital.

To anyone accustomed to the elaborate records now available in our better hospitals upon such subjects as chronic cardiac or renal disease, the brief and inconclusive statements which characterize the hospital records of gas poisoning come as something of a shock. Occasionally full notes are found, but ordinarily the patient recovers or dies without arousing significant interest. That gas poisoning in man may be a profitable field for medical investigation does not seem to have been considered, and this in hospitals where less common and less dangerous diseases are receiving large amounts of study and attention. On account of the meager records available, we have confined our final analyses to a small number of the most pertinent items. A brief inspection of Table 4 will serve to show that the items chosen do not, in the main, require great subtlety

of diagnosis or great effort in recording. Where pneumonia has occurred, there has usually been a lapse of several days following admission to the hospital. The records improve in such cases and follow the usual trend that one expects in the description of an acute infection.

The facts presented in Table 4 are strikingly uniform and bear upon the immediate problem of resuscitation in the following items:

1. 59.8 per cent. of the gassed patients were unconscious on admission to the hospital or were reported as unconscious when found.

2. 44.4 per cent. were breathing rapidly. Only in rare cases was the breathing very slow.

3. The admission pulse rate was high, averaging 104 for the entire series of cases.

4. The records show an average of 6.4 per cent. of patients frothing at the mouth; 17.4 per cent. with râles in the lungs; and 4.5 per cent. with pulmonary edema.

These findings were undoubtedly present in very large part when the patients were first picked up by rescue squads. It thus becomes at once apparent that resuscitative measures in gas poisoning must, in large measure, be applied to unconscious patients who are breathing rapidly, who have rapid hearts, and who, in a large percentage of cases, have excess fluid in the respiratory tract. We have already commented upon the possible dangers of positive ventilation of the lungs in conditions such as these figures show to be very frequent in gas poisoning.

It will be noted that the percentage of pneumonias following gas poisoning is not high. The fact that fatal cases almost invariably show a rise in temperature makes it seem probable to us that some degree of bronchopneumonia must be present in nearly all patients who do not succumb immediately following their exposure to gas. The pneumonia in such instances is probably only a contributory cause of death, fatality being due, in the main, to cardiac and central vasomotor failure. Our table, therefore, tells the story of the severe and unmistakable pneumonias alone. Only by careful autopsy reports can the full quota of pneumonias be ascertained.

A comparison of the figures obtained in our study with the findings reported by other observers is of interest. Gilman Thompson (2) in 1904 made an analysis of ninety cases of illuminating gas poisoning occurring in New York City, and Lämpe (3) in 1921 reported a series of 205 cases treated at the Dresden-Johannstat municipal hospital during the years 1912 to 1921. Only patients sufficiently gassed to become unconscious were included in these two studies. The mild cases were thus eliminated, and a somewhat more serious picture of gas poisoning is presented than the figures given in Table 4 suggest. Table 5 gives an analysis of the findings in the 514 unconscious patients in our series of cases and may, therefore, properly be compared with the observations which were reported by Thompson and Lämpe.

The mortality in Thompson's series was 18.8 per cent.; in Lämpe's, 17.6 per cent.; in ours (unconscious patients only), 22.6 per cent. The first 54 of Lämpe's cases, occurring during 1912, 1913, 1914 and 1915, had a death rate of only 5.6 per cent. During the 1916 to 1921 period the mortality rose to 21.8 per cent. The percentage of carbon monoxide in the illuminating gas in Dresden during this same period increased as follows: 1913, 8.4 per cent.; 1914, 10.8 per cent.; 1915, 12.2 per cent.; 1916, 14.3 per cent.; 1917, 16 per cent.; 1918, 18.4 per cent.; 1919, 21.6 per cent.

TABLE 4.—CASES OF ILLUMINATING GAS POISONING IN BOSTON, PHILADELPHIA, AND NEW YORK

	1906-1909 1918-1921	1908-1921	1904-1917 1922	Percentage			Summary
	Boston	Phila-delphia	New York City	Boston	Phila-delphia	New York City	Boston, New York and Philadelphia
				%	%	%	%
Total number of cases	235	220	405	—			—
Average age on admission	41	39	39	—	—	—	—
Deaths	32	26	67	13.6	11.8	16.5	14.5
Number unconscious	143	142	229	60.4	64.6	56.5	59.8
Number frothing at the mouth	14	13	28	6.0	5.9	6.9	6.4
Number respiration 26 or below	54	117	224	43.2	59.1	57.9	55.6
Number respiration above 26	71	81	163	56.8	40.9	42.1	44.4
Average pulse on admission	108	102	104	—	—		—
Average temperature on admission	98.4°	98.4°	99.1°	—	—	-	—
Average last temperature recorded before death	—	104.4°	103.6°	—	-		—
Lung findings:							
Râles	45	24	73	19.1	13.6	18.0	17.4
Edema	8	12	17	3.4	6.8	4.2	4.5
Pneumonia	7	7	34	3.0	4.0	8.4	5.9
Total with abnormal moisture in respiratory tract	60	43	124	25.5	24.4	30.6	27.8
Abscess	—	1	—	—	—	—	—

TABLE 5.—CASES OF ILLUMINATING GAS POISONING IN BOSTON, PHILADELPHIA, AND NEW YORK: UNCONSCIOUS PATIENTS ONLY

		1906-1909 1918-1921	1908-1921	1904-1917 1922	Percentage			Summary
		Boston	Phila-delphia	New York City	Boston	Phila-delphia	New York City	Boston, Philadelphia and New York City
					%	%	%	
Total number of cases		143	142	229	—	—	—	514, total cases
Deaths		29	25	62	20.3	17.6	27.1	22.6%
Frothing at mouth		13	10	26	9.1	7.0	11.4	9.5%
Respiration on admission	26 or below	30	70	100	35.7	53.0	46.5	46.4%
	above 26	54	62	115	64.3	47.0	53.5	53.6%
	av. per min.	30	27	28	—	—	—	28, av. per min.
Pulse on admission	below 100	18	54	53	21.2	41.5	26.2	30.0%
	100-120	49	55	109	57.6	42.3	54.0	51.1%
	above 120	18	21	40	21.2	16.2	19.8	18.9%
	av. per min.	110	103	107	—	—	—	107, av. per min.
Temperature on admission	below 97°	14	21	42	16.3	15.8	18.9	17.5%
	97°-99°	48	72	75	55.8	54.1	33.8	44.2%
	above 99°	24	40	105	27.9	30.1	47.3	38.3%
	av.	98.2°	98.4°	98.9°	—	—	—	—
Lung findings	Râles	30	18	52	21.0	15.7	22.7	20.5%
	Edema	8	12	15	5.6	10.4	6.5	7.2%
	Pneumonia	6	7	33	4.2	6.1	14.4	9.4%
	Total with moisture	44	37	100	30.8	32.2	43.6	37.2%

This increase in the carbon monoxide content of the gas offers a very probable explanation of the mortality rise.

Of our unconscious patients, 53.6 per cent. were breathing at a rate above 26 per minute, the average respiration rate for the entire group being 28 per minute. Thompson reports that in his patients the respiration rate averaged about 30 per minute. In Lämpe's cases the average range was from 24 to 32, the rate being "seldom quite normal."

Thirty per cent. of our unconscious patients had a pulse rate, on admission to the hospital, of below 100 per minute; 51.1 per cent. had a rate of between 100 and 120; 18.9 per cent. had a pulse rate of over 120; the average rate was 107 per minute. Thompson reports marked acceleration of the pulse. The count was seldom below 120 and frequently reached 136 to 140. Lämpe reports a pulse rate of 140 and above in the severe cases, and a tachycardia (no rate specified) in the less serious ones.

Thompson observed an elevation of the temperature in almost all of his patients. In eight cases there was a preliminary fall. Lämpe reports that in most cases the temperature did not rise above 38° C. (100.4° F.) though occasionally it reached 40° C. (104° F.). Of our patients, 17.5 per cent. were admitted with a temperature below 97° F.; in 44.2 per cent., the admission temperature ranged between 97° and 99°; in 38.3 per cent., the temperature was above 99°.

In discussing the lung findings, Thompson says, "Occasional sequelae are bronchitis, broncho and lobar pneumonia." Later he says, "It was a surprise to the writer that bronchopneumonia, or other definite pulmonary lesion, is not more constantly an outcome of fatal gas poisoning, but in only three of the twelve autopsies was bronchopneumonia observed." The lung findings, however, in the twelve autopsies which he reports showed normal lungs in only 25 per cent. of cases. The autopsy findings were as follows: normal, 2 cases; normal, except for a few miliary tubercles, 1 case; congestion (complete), 1 case; congestion and edema (complete), 3 cases; congestion and edema in partial areas, 5 cases; emphysema (partial and compensatory), 4 cases; atelectasis (partial), 2 cases; bronchopneumonia, 3 cases. There is no mention of physical examinations of the lungs of patients who recovered, so we have no means of judging the incidence of transient lung changes in Thompson's cases.

The lung findings reported by Lämpe were the frequent occurrence of bronchitis, 1 case of edema (with frothy sputum), 10 cases of bronchopneumonia, 2 cases of pleuritis without bronchopneumonia, 7 cases of hypostatic pneumonia, 4 cases of aspiration pneumonia, and 2 cases of gangrene of the lungs—a total of 12.7 per cent. of cases with lung involvement, exclusive of the cases of bronchitis.

Of our unconscious patients, 20.5 per cent. had râles; 7.2 per cent., edema; and 9.4 per cent., pneumonia—a total of 37.2 per cent. with abnormal moisture in the lungs.

Summary of Section II

An examination of hospital records in three representative eastern cities shows:

1. An average death rate of 14.5 per cent. of cases which have passed beyond the stage of first-aid treatment and have become hospital patients.
2. A high average pulse rate.
3. A group comprising 27.8 per cent. of the total number studied who have undue moisture in the lungs.

Conclusions

1. No evidence has been obtained from representative gas companies which indicates that either the lungmotor or the pulmotor is superior to the manual prone pressure method of artificial respiration.

2. The evidence obtained leads to the conclusion that if apparatus is to be employed to supplement this simple method of artificial respiration, it should be in the form of some device to provide inhalation of oxygen and carbon dioxide as recommended by Henderson and Haggard.

3. Evidence gathered from hospital records indicates that in gas poisoning any method of artificial respiration which drives air by positive pressure into the lungs may be a source of danger to the patients treated. Devices such as the pulmotor and lungmotor operate in this way and consequently would seem to require further investigation before being recommended for use in gas poisoning.

4. Owing to the fact that other physiological factors enter the problem of artificial respiration in gassing, the Commission has undertaken a series of experiments upon further phases of the problem and will offer final recommendations at a later date. At the present time, the best directions for rescue crews are those already given by Henderson and Haggard—namely, immediate use of the Schäfer prone pressure method of artificial respiration in non-breathing cases, supplemented as soon as possible by oxygen carbon-dioxide inhalations given through a suitable inhaling device.

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INDUSTRIAL MEDICINE IN 1922*

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Industrial medicine has now been practiced in the United States about ten years. At first a new field not thoroughly understood, it has gradually taken shape until at present the term has a distinct meaning, and the industrial physician a specific classification.

During the formative period a number of what were originally fundamental ideas have changed and methods at first unnecessarily elaborate have been simplified. It seems that this is a good time to review the present situation and to try to outline the beliefs and practise of today. It is generally recognized that the success of an industrial medical department depends largely upon two things: the character and training of the physician, and the co-operation of the management.

The Conference Board of Physicians in Industry has recently defined the industrial physician:

> The physician in industry is one who applies the principles of modern medicine and surgery to the industrial worker, sick or well, supplementing the remedial agencies of medicine by the sound application of hygiene, sanitation, and accident prevention; and who, in addition, has an adequate and co-operative appreciation of the social, economic and administrative problems.

Thus, it is now believed that the difference between a physician in general practise and an industrial physician consists in the latter's appreciation of the problems of industry and the application of the art and science of medicine and surgery to these problems. He is more truly a physician in industry than an industrial physician.

Co-operation of the management means active participation in the medical department plus interest in its aims and accomplishments. The management should use the department as freely and willingly as the worker. An intelligent review of the accomplishments of the medical department will determine its value to the organization. That the value is now recognized is shown by the fact that "during the industrial and business depression, through which the country has just passed, there was ample opportunity for considering the value of various non-productive industrial activities, and the fact that the medical department in industry has retained its standing and importance to a relatively higher degree than have many other non-productive activities, is evidence of the value of the work" (1).

The basic activities of the medical department have always been:

1. Physical examination of applicants for employment.
2. Treatment of accidents and sickness occurring within or outside the factory.
3. Preventive medical measures.
4. Supervision of sanitation.
5. Nursing service.

The present methods of handling each of these will be considered.

Physical Examination of Applicants for Employment.—It is now recognized that whenever possible the examination should be made before employment at the factory, and by a physician. The

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length of time allotted to each examination is from six to fifteen minutes. The object of the examination is to determine whether the applicant is physically suitable for the work to which he is assigned by the employment department. If he is not, work in some suitable department should be provided if such work is available, unless the physician considers the employment of the individual a danger to himself, to others, or to property. If for the foregoing reasons the applicant is refused employment, the reason for his rejection should be explained to him fully and advice given him.

The physical examination is made for the purpose of discovering defects which contraindicate employment or which require placement. Thus special attention has been drawn to certain conditions. Watson (2) has listed these as follows:

(*a*) Active pulmonary tuberculosis.

(*b*) Cardiac disease with potential or established decompensation.

(*c*) Active or chronic venereal disease.

(*d*) Acute contagious disease.

(*e*) Chronic progressive disabling disease, such as Bright's disease and diabetes.

(*f*) Potential and active focal infection.

(*g*) Defective vision and hearing of a degree incompatible with the requirements of a given industry.

To this list should be added chronic disease of the joints, particularly the joints of the spine and lower extremity.

The following conditions previously considered dangerous are now considered safe if the worker is properly placed and watched:

(*a*) Hernia, if held by a truss (3).

(*b*) Varicose veins, if ulcer is absent.

(*c*) Varicocele.

(*d*) Flatfoot, if without symptoms.

(*e*) Deafness, except in special departments.

(*f*) Defective vision, except in special departments.

(*g*) Arteriosclerosis.

(*h*) Endocarditis unaccompanied by marked myocarditis (4).

Criticism has been made that six minutes is too short a time to be allowed for examination; thus "five or six minutes may be enough for an examination conducted under rigid military discipline; but such a discipline will not make the doctor and his assistants popular with the worker; it will not secure a desire on his part to seek advice and submit voluntarily to further examination should the state of his health require it" (5).

This criticism has not been borne out by experience. The reason that the examination can be made rapidly is because the time of undressing is eliminated and all examining apparatus and instruments are at hand. Unless applicants receive quick and accurate service, the work of the employment department is retarded and the applicants themselves complain. Accurate work can be done in the time indicated, and employees do return voluntarily for further examination and treatment where this is needed.

Where a serious defect is discovered and the applicant placed at suitable work, he is reexamined at intervals, his condition is recorded, and advice is given. In many factories this reexamination is very complete and takes about one-half hour, a special record being filled out. The types of patients receiving special attention are those with cardiac disease, nephritis, arrested pulmonary tuberculosis, and hernia. A periodic examination is also given to workers who are exposed to special

health hazards or who work in poisonous processes.

Treatment of Accidents.—The first-aid treatment once so widely advocated and stretched into redressings has been simplified and confined to narrow limits. This has increased its efficiency. "First aid means the immediate treatment of personal injuries by any one other than a doctor" (6). It is carried on by a non-medical, trained person who is near at the time of the accident. It is therefore common in large factories to have in each department where there is hazard a group of trained workers who are capable of carrying out such immediate treatment as is necessary.

According to Shoudy (7), there are four cardinal points to be taught in first aid, to which other things may be added as necessary. These points are:

1. Shock—its symptoms and treatment;
2. Hemorrhage—how to control by direct pressure, seldom by tourniquet;
3. Asphyxia—its causes, symptoms and treatment; artificial respiration by the Shaeffer prone pressure method only;
4. Transportation—careful handling of the injured in a minimum of time, so as not to cause pain or further trauma, is one of the most important things taught first aid classes.

In most factories employing over 150 employees there is now a dispensary with a trained nurse or doctor in attendance, so that first aid consists in doing only what is immediately necessary and then rapidly transporting the patient to the dispensary where proper treatment may be applied. The day when the "first aid man applied antiseptics to wounds and removed foreign bodies from eyes has passed."

In the majority of factory medical departments the treatment of all open wounds has been standardized. This treatment consists in flushing or washing the wound with gasoline, and then applying tincture of iodine either full or half strength by sterile cotton applicator or by medicine dropper. In some factories a soap and water cleansing, followed by the application of Dakin's solution or Dichloramin-T., is preferred; as it is more complicated, however, and requires in the case of Dakin's solution a moist dressing, which may irritate the skin, the gasoline and iodine sequence is preferred. In the treatment of fractures, the Thomas type of splint, such as is used in the United States Army, has come to be the standard transportation splint.

The number of solutions used in factory dispensaries has also been greatly reduced, and it is hoped that soon one or two standard solutions for wet dressings will be all that are necessary.

It will be seen from the foregoing that the present practise is to reduce and simplify wherever possible, and a strong effort is being made to standardize treatment wherever this can be safely done.

Along with reduction of solutions and apparatus, there has been a move toward grouping treatments. For example, all clean hand and arm injuries are treated at one part of the dispensary, all infections (boils, etc.) at another, and all eye cases in a special eye room. This is called the unit method of treatment, and is in force in the dispensaries of all large factories.

By these newer methods it has been possible to increase the rapidity of treatments and to reduce the waiting period of those requiring dressings.

Diagnosis and Treatment of Sickness. Every large factory is a community in itself and presents the public health problems of a small village. Epidemics must be prevented, sanitation must be kept at a high standard, and industrial disease due to specific poisons must be eliminated. As a result of these needs,

industry requires a certain amount of public health knowledge and activity in its medical department. Instead of merely diagnosing and treating individual cases the health condition of the factory as a whole is considered, and morbidity statistics are kept and reviewed at frequent intervals. In some factories a health insurance plan is carried out, whereby a portion of the employee's wages are paid to him when he is out sick. A system of this kind acquires most accurate records and allows the physician in charge to analyze the causes of absenteeism and to plan preventive measures when these are possible.

Diagnostic methods have been more fully applied each year. While few factories have elaborate laboratories, most factories have laboratory equipment of some sort and an increasing number have their own X-ray outfits. The diagnosis of obscure cases is usually referred to the patient's physician or to a general hospital, but many rather difficult diagnoses are now being accurately made in industrial medical departments.

Treatment of sickness still is very minor. All the emphasis is being placed on prevention, and efforts are being made to check beginning colds, stomach disorders, and similar conditions which may later cause severe sickness. The following up of chronic heart, kidney and goiter cases is another function which is being elaborated upon.

The plan of sending all really sick employees to their family physician or to a general hospital is still adhered to, and many more patients are being referred to specialists for treatment of the eyes, ears, nose or throat than formerly. Incidentally, the general and special practitioner is co-operating with the industrial physician more freely each year. While some factories have worked out special treatments for common minor diseases such as coryza, no one treatment for any condition has been successful enough to become standardized.

Preventive Medical Measures.—These have been discussed in the preceding sections.

Sanitation.—Nothing particularly new has been added to sanitary inspection, except that more strict standards are being required by states, and various engineering societies have studied lighting and ventilation, particularly lighting. The result has been the production of an American Standard Industrial Lighting Code (8). This is the result of long and painstaking work and has been officially approved as an "American Standard" by the American Engineering Standards Committee. It has been submitted to, and approved of, by thirteen national organizations, and is the basis of a proposed lighting code advocated by the Department of Labor and Industries of the state of Massachusetts. Similar codes of industrial ventilation and exhaust systems have been published by the National Safety Council (9). Thus, there is a continuous process of standardization of sanitation proceeding, and manufacturers are interesting themselves in it more each year.

The industrial physician is constantly presenting constructive suggestions before the management so that the general sanitation of factories is improving.

Nursing Service.—The industrial nurse has become a *sine qua non* in industrial medicine. Both as a dispensary assistant to the doctor and as a visiting nurse, her value is now definitely recognized. In some states every factory employing more than a certain small number of employees must provide a small dispensary with a trained attendant. So great has been the call for nurses in in-

dustry that in some communities the regular nursing has suffered.

The visiting nurse combines social service work with nursing visits, and acts as a connecting link between the factory and the worker's home.

The response of workers to the work of the industrial medical department has been most encouraging. Physical examinations are seldom refused, and in a medical department which has been in activity for several years, the dispensary is in continuous use. A factory with 2,000 employees will show an average of seventy-five visits a day. This alone demonstrates the need for medical service and the worker's appreciation of it.

Considering the recent business depression with its economies and reductions of working force, it is remarkable that industrial medical departments were not more affected. With increasing business there is every indication that industrial medical departments will continue to develop and become even more valuable to both worker and management than they have been in the past.

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THE VENTILATION OF ENGLISH FACTORIES AND WORKSHOPS IN HOT WEATHER*

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A LARGE rubber manufacturing firm with an expanding trade during the war moved a great part of its works from old premises in a town to newly erected buildings in the open country. These new buildings, for the most part single story structures of the "saw tooth" type, were more roomy, better lighted and altogether more convenient than the old factory. As in the old buildings, however, many parts of them became far too hot in the summer time—so hot, in fact, that it was believed that the general health and efficiency of the workers were impaired, and that the labor turnover was made unduly high, many workers whose training had cost time and money having to leave because they were unable to bear the conditions.

It became the writer's task to investigate these conditions and by applications of the principles of Dr. Leonard Hill, with whom he has the good fortune to work, to indicate their causes and to suggest practical remedies.

Description of the Buildings

The buildings are steel constructions with brick ends and sides, the "saw tooth" roofs having alternate slopes of glass (facing north) and double roofing of asbestos sheets covered with felt with air-space between. When these buildings were first erected they had no windows at the ends or the sides, and no openings were provided save the necessary doors and four 12-inch ventilation holes in the roof to each space enclosed between any four stanchions in the buildings. These spaces had an approximate cubic content of 10,760 cubic feet, so that the 12-inch holes gave to the entire buildings a natural ventilation figure of 0.292 square feet of opening per thousand cubic feet of enclosed space. This natural ventilation figure was found to be useful in estimating the probable effect of different windows and lights, and will be referred to again; 0.292 is an extremely low value.

All the buildings can be effectively heated by an exhaust steam system, the pipes for which are carried along under the roof at a height of 11 feet and 6 inches above the floor.

Nature of the Work of the Factory

Most of the manufacturing processes used in these works call for no great physical effort, and can be carried out under ordinary conditions of heat, light and air, but two particular operations—curing and solutioning—require the workers to be exposed to high temperatures.

Curing and Solutioning.—In the curing or moulding shops the goods are placed in large receptacles or pans, into which live steam is admitted for the period required. The steam is then blown off and the pan opened to remove the cured articles. In this way a large amount of hot air and water vapor is released into the air of the department.

In the solutioning rooms a high temperature has to be maintained in order to prevent the moisture in the air from condensing on the solutioned surfaces of the goods, which may be cooled to the

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dew-point of the air by the evaporating solvent. The only practicable means that has so far been found of preventing this condensation, the occurrence of which spoils the process, is to raise the temperature of the air in the shops where the solutioning is done.

Previous Attempts at Improving Conditions

The management of this factory was anxious to discover some means by which conditions might be improved in hot weather, and in one of the departments experiments had been made with an air trunk or blast system, before the writer undertook the ventilation work. The effects produced by this system were as follows:

In a department of about 129,100 cubic feet content, where nearly all the work done produced no heat or effluvia, three 12-inch fans delivered air into 9-inch sheet iron trunks which were carried along the walls on either side of the building at a height of about 8 feet above the floor. At short intervals along these trunks long, thin horizontal slots were formed, through which the air was intended to flow down and out at an angle of 45° toward the floor, while in a direction perpendicular to the axis of the trunk.

The air was drawn in from under cowls on the roof, and before entering the trunks was passed through heaters that could be supplied with exhaust steam in cold weather. As the static pressure in these trunks was extremely low, and the energy of the air was almost entirely kinetic, the air in the greater part of the building was unaffected, the drafts produced being only very local, and in a line almost parallel with the direction of the trunk. Where currents from either fan met and opposed each other there was a powerful local draft.

The layout of this department with the positions of the trunks and the directions and relative velocities of the air currents is shown in Figure 1.

Air Changes or Renewals Produced.—It was found that in the above department each of the three 12-inch fans, used to supply air to the trunks and similar fans, on test, delivered not more than 1300 cubic feet of air per minute. This should change the air $\frac{3,900 \times 60}{129,100} = 1.8$ times per hour.

Thompson gives the air changes per hour desirable in textile mills as 4, and in foundries as 3. Allen and Walker give the cubic feet of air required in workshops per occupant per hour as from 600 to 2,000. By Thompson's standard the fresh air supplied by these fans is quite insufficient, and by Allen and Walker's it is more than enough, there being only about fifty workers employed at one time in this building. If we consider that each worker requires 1,000 cubic feet per hour in this clean shop, the total fresh air required per hour = 50,000 cubic feet, while the three fans together supply 234,000 cubic feet per hour.

Situation Reviewed

Considering the problem generally, it appeared to the writer that the use of a trunk or blast system here was wrong in that it only produced, by a costly and bulky method, a renewal of air that could be quite well brought about by open windows and skylights with, perhaps, one or two inexpensive propeller type fans. What we aimed at was the ease and comfort of the workers, not the pumping in of an arbitrary quantity

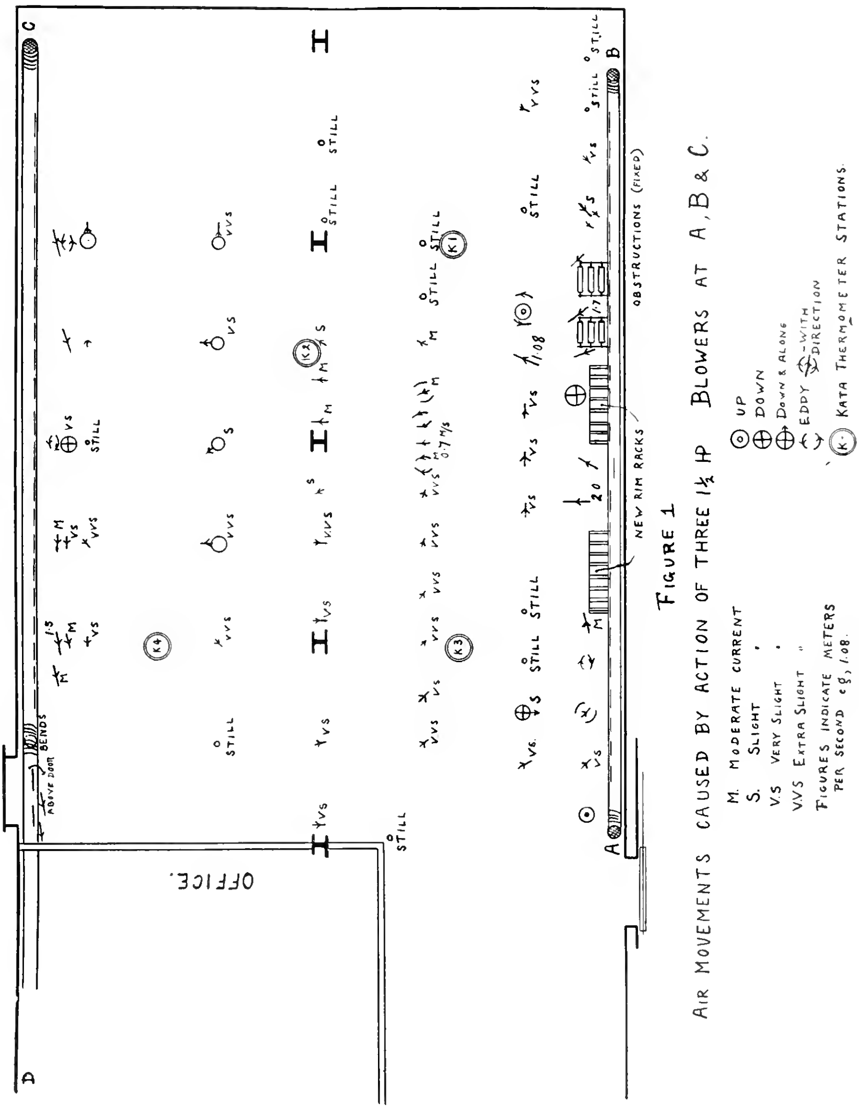

FIGURE 1

AIR MOVEMENTS CAUSED BY ACTION OF THREE 1½ HP BLOWERS AT A, B & C.

of air so that it could be said that the shops were properly ventilated; this would not increase the production of the factory nor lessen the labor turnover.

Dr. Leonard Hill's Methods and How They Were Applied

Dr. Leonard Hill's kata-thermometer is at present the best means available by which those physical conditions of the atmosphere that affect health may be measured, and for the benefit of those who are not familiar with this instrument a short account of its principles is given.

The working human body can be considered as a heat engine consuming its fuel (food) with an overall thermal efficiency of about 25 per cent.; that is to say, it has to dissipate to the surroundings about 75 per cent. of the heat energy of the food eaten and digested, in the same way that an automobile, in order to work without overheating and without being forced to stop, has to dispose of about 80 per cent. of the heat of its petrol's combustion through its radiator and exhaust pipe, and from the surfaces of its engine. The human engine's radiator is its skin, externally on the body surface and internally on the respiratory membrane, through which heat is lost by contact with air at a temperature lower than its own, and by the evaporation of moisture from the warm surfaces, which can always take place as long as the air is not saturated. These most essential interchanges of heat are thus governed by the physical condition of the air surrounding the body. The kata-thermometer has been invented by Dr. Hill to enable us to measure and compare these physical conditions as they occur in everyday life.

The kata-thermometer[1] is a large bulbed spirit thermometer, the bulb of which is heated well above body temperature for each observation. The instrument is then suspended freely in the air that is to be tested, and the time taken by the meniscus to fall from 100° F. to 95° F. is measured (the mean of these figures being taken as the temperature of the skin).

As is well known, the amount of moisture present in the air has a great influence on comfort, and if it is remembered that evaporation plays an important part in disposing of the body's waste heat, the reason for this is clear. The kata-thermometer can be used as a dry or wet bulb, and in the latter case it has been proved that the additional increased cooling rate obtained is entirely due to the evaporation of the water from the wet jacket. This evaporation loss is greatly increased by air movements.

Dr. Hill in "The Science of Ventilation and Open Air Treatment"[2] maintains that alterations in the cooling and evaporative powers of the air acting on the human body, as measurable by the kata-thermometer, have a vastly greater effect upon human comfort and fatigue than have changes in the chemical composition of the air in crowded rooms. He has pointed out that the atmosphere of a stuffy London workshop contains a greater concentration of oxygen per cubic foot than the air at a Swiss mountain health resort, and that the very different physical effects and sensations produced in these places is due to other causes than diminution of oxygen. He has recorded kata-thermometer readings in factories, schools, mines, aeroplanes, army huts, and in roads, gardens, fields, on the seashore and mountains, and has collected readings from all parts of the world. He has taken

[1]Made by J. Hicks, 8, Hatton Garden, London, E. C.

[2]Hill, L.: Science of Ventilation and Open Air Treatment. Parts I and II. Med. Research Council, Special Rep. Series, Nos. 32 and 52. London, 1919, 1920.

readings in schoolrooms ventilated and heated by plenum systems, by open windows and hot water pipes, and has found that in the "plenum" rooms monotonous conditions obtain that tend to keep the occupants from enjoying an active and vigorous state of mind. He a factory in hot weather. To make work in a factory in hot weather no more trying than working out of doors in the shade in hot weather, we must imitate indoors, by any means in our power, the constant small movements of air that take place out of doors in the stillest of

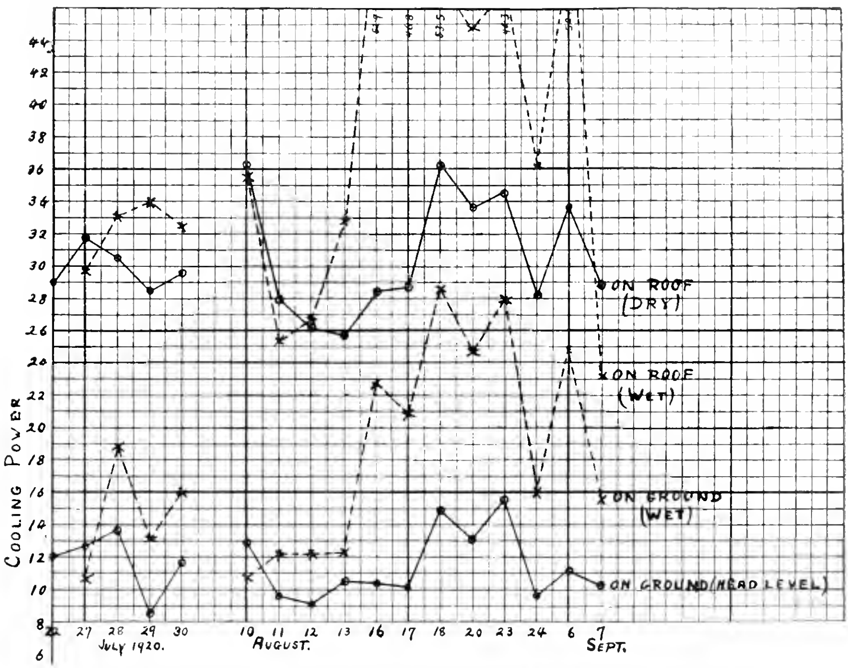

FIG. 2.—Kata-thermometer readings taken in two positions outside the factory.

has also shown that this cooling power depends not only upon the temperature of the air but upon its *movement* past the body that it has to cool, and that movement has a greater effect upon the cooling power than temperature has, so that working in gently moving air at 85° is far more comfortable than working in still air at 80°.

Here seems to lie a key to the problem of keeping good working conditions in weather. Provided the air is reasonably clean and free from dust, we shall then introduce into our factory much of the freshness that is considered inseparable from outdoor life.

Kata readings taken outside a factory on a sunny day may show a cooling power of 15, and inside the factory at the same time the kata may show a cooling power of only 5, although the inside of the building may be only 4 or 5 degrees

hotter than the outside shade temperature. This great difference is due solely to the stillness or stagnation of the air in a closed space.

The accompanying graphs show a number of kata-thermometer readings taken within the same two hours over a number of days: Figure 2 gives those taken in two positions outside the factory; Figures 3, 4 and 5 give those taken in certain positions in different departments of the factory while work was actually in progress. The upper curves are from the wet kata readings and the lower are from the dry kata readings. The great differences that occur between the outdoor readings from day to day in the fickle English climate will be noted.

The figure for opening space, which accompanies each indoor reading, is an indication of the natural ventilation available through open doors, skylights and ventilators in the department under consideration. This figure is obtained by multiplying the approximate free area in square feet of all openings by 1,000, and dividing the product by the cubic foot contents of the building, giving square feet of opening per thousand cubic feet of space in the building.

In this connection Figure 3 should be especially noted. Here the broken line indicates readings in the old moulding or curing shop, a place containing many steam curing pans and provided with comparatively small vents for the hot air, or side openings for cool air to enter. The opening figure is 2.32 and the lowest dry kata cooling power is 0; the temperature when this reading was taken was above 96.5° F. The solid line pertains to the new moulding shop where bountiful side windows and roof lights are provided. Here the opening figure is 8.66, and the lowest dry kata reading is 4.

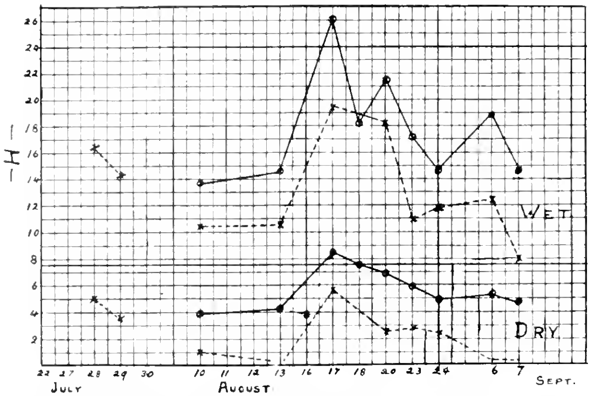

FIG. 3. Kata-thermometer readings taken in new moulding shop and in old moulding shop.

Solid line=new moulding shop; broken line=old moulding shop.

In new moulding shop doors=7.3; roof openings=1.36; making opening figure 8.66.

In old moulding shop doors=1.62; roof openings=0.70; making opening figure 2.32.

In these two departments the work done and the sources of heat are identical; in the first department men be-

come bathed in sweat after a few minutes' work, and are generally exhausted by the end of the day; the other department only impresses the worker as being "rather too warm." The difference heat are found in these works, and where structural alterations were called for, in order effectively to dispose of the large quantities of heat, steam and fumes that are inseparable from the

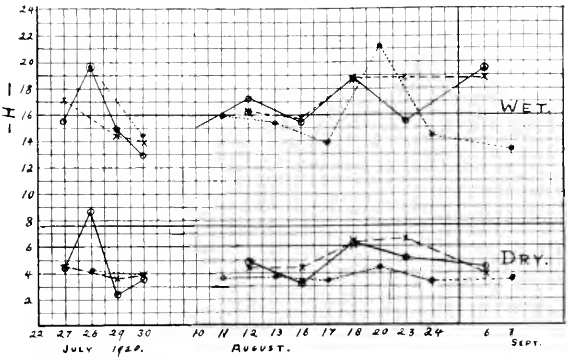

FIG. 4.—Kata-thermometer readings taken in mixing mill and in extruding shop.

Dotted line=mixing mill; solid and broken lines=extruding shop.

In mixing mill doors=1.64; no roof openings; making opening figure 1.64.

In extruding shop doors=0.85; roof openings=0.96; making opening figure 1.81.

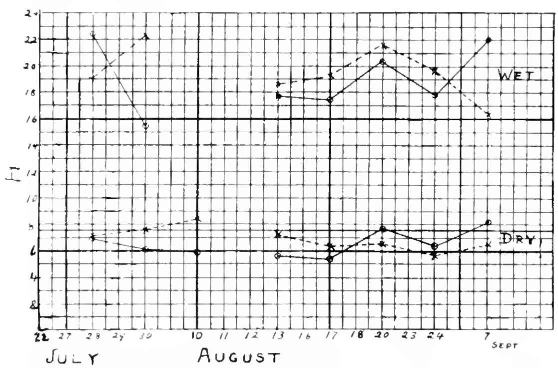

FIG. 5.—Kata-thermometer readings at two stations in test department at same hour.

Doors=1.55; roof openings=1.70; making opening figure 3.25.

is obtained by no greater effort than a careful provision of natural ventilation openings.

The departments cited are two of those where the greatest excesses of processes. We have now to consider the larger part of the factory where processes entailing no large production of heat are carried out, but where the sensations and the kata-thermometer prove

that the conditions are too enervating.

A typical series of kata readings for such a place is shown in Figure 4. These readings were taken in the mixing mill and extruding shop, where the opening figures are 1.64 and 1.81, respectively; while the average dry kata reading is about 4.5, and the wet kata 17, instead of the figures 7.5 and 24, which are considered ideal for moderate physical work. Compare these figures with those for the test department (Fig. 5) where the opening figure is 3.25, and the dry and wet katas 6.5 and 19.

It is plain that roof and wall openings, though of great use in hot weather, will, even if the construction and position of a factory permit their being made, be only a partial remedy for stuffy conditions in hot weather. At best it is only reasonable to suppose that natural ventilation can keep the inside temperature down to that of the outside air, and in practice even this is rarely attained. The ideal factory would be one with walls which could be entirely removed in summer, so that the occupants, while shaded from the sun, would be stimulated by the constant movements of the air.

In public buildings and theatres ventilation engineers are in the habit of relieving stagnation of the air by introducing conditioned air at a suitable position at one side of the room and removing it at the other; a given volume of air thus traverses a space of known volume at a known average velocity. It is hardly necessary to point out that a conditioned air supply to a factory like the one under investigation, besides being quite unnecessary, would be altogether out of the question.

In small rooms and offices air movements can be produced at will by small electric fans, and in restaurants by larger fans suspended from the ceiling. Both of these have the desired effect: they "make the place feel cooler and fresher"—that is to say, they cause the air to move faster around the bodies and faces of the people present, and this air, being cooler and dryer than the surfaces, has a pleasant cooling effect.

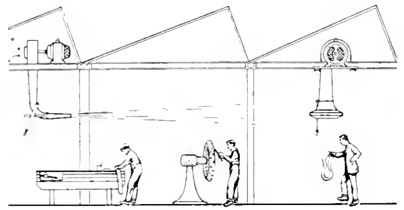

Fig. 6.—Side and front views of jet tubes as fitted up in a factory.

It appeared to the writer that none of the usual methods of promoting air movements were applicable to factory conditions, where cooling effects, to be of any real use, must be produced over very large floor spaces, and at the level of the head and shoulders rather than at the level of the feet, and must in no part of the building cause unpleasant drafts.

The Jet Tube.—In order to meet these conditions the writer introduced the jet tube system, by means of which it was hoped to cause air movements of the right kind over a large floor area. A jet tube consists of a sheet iron tube or trunk terminating in a wide, flat opening, through which air is driven with high velocity by means of a low pressure centrifugal fan. The flat, wide stream thus produced passes well over the heads of the people but its force is sufficient to set in motion a great volume of air around its path. This surrounding air gets a general drift in the direction of the jet but it is also thrown into eddies and whirls that to some extent

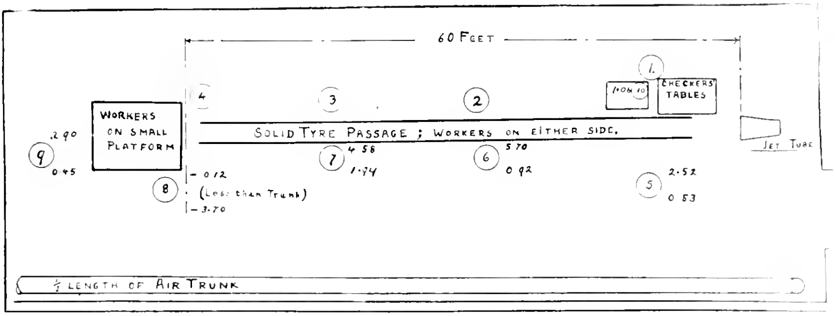

FIG. 7.—Kata-thermometer stations during air trunk and jet tube test in erecting shop. Cooling power increases due to jet tube at head and feet are marked beside stations. For example, at station 6, the increase was 5.7 at head level, and 0.92 at foot level. At station 8 the jet tube had less effect than the air trunk.

TABLE 1.—COMPARISON OF EFFECTS OF JET TUBE AND OF AIR TRUNK

Position and Fans	Temperature at Shoulder Level		Dry Kata Cooling Powers		Cooling Power Increase	
	Dry	Wet	At Head	At Feet	At Head	At Feet
	°F.	°F.				
1. All off	74.0	65.0	4.36	4.75	−0.15	0.22
Trunk on	74.0	65.0	4.21	4.97		
2. All off	74.5	64.5	4.70	5.05	−1.45	−0.08
Trunk on	74.0	64.0	3.25	4.97		
3. All off	75.0	64.0	3.98	4.44	1.13	3.83
Trunk on	74.0	63.0	5.11	8.27		
4. All off	74.0	65.0	4.40	4.50	0.10	0.72
Trunk on	73.0	64.0	4.50	5.22		
5. Trunk on	79.0	72.0	3.98	3.47	2.52	0.53
Jet tube on	79.0	70.5	*6.50*	*4.00*	(increase over trunk)	
6. All off	77.5	70.0	4.00	3.98		
Trunk on	77.0	70.0	4.37	3.92	0.37	−0.06
Jet tube on	78.5	69.0	*9.70*	*4.90*	5.70	0.92
7. All off	78.0	71.5	3.68	3.65		
Trunk on	76.0	69.0	5.31	5.74	1.63	2.09
Jet tube on	78.0	69.5	*8.26*	*5.59*	4.58	1.94
8. Trunk on	76.0	68.0	6.34	8.30	−0.12	−3.70
Jet tube on	78.5	69.5	6.22	4.60	(less than trunk)	
9. All off	78.0	71.5	3.60	3.55	0.55	0.04
Trunk on	78.5	71.5	4.15	3.59		
Jet tube on	79.0	70.5	6.50	4.00	2.90	0.45
10. All off	78.0	71.0	3.36	—	1.06	—
Jet tube on	79.0	71.0	4.42	—		

prevent the monotonous sensation produced by a steady current of air. The jet, though starting at a height well above the heads of the occupants, is generally slightly canted downwards so that as its force lessens with distance, its

effect is increased as it nears the floor.

In this way it was found that a single jet tube supplied with air by a $1\frac{1}{2}$ horse power motor had a measurable effect over a floor space of roughly 100 feet by 15 feet, and that five jet tubes could keep in motion the whole air in a large building.

ing power should be about 7.5 and that without artificial ventilation the cooling power was only from 3 to 4.5 on a hot, stuffy day, it will be seen that the jet tube produced a marked cooling effect on all the workers in a space of more than 700 square feet. It will also be noted that this was invariably greater

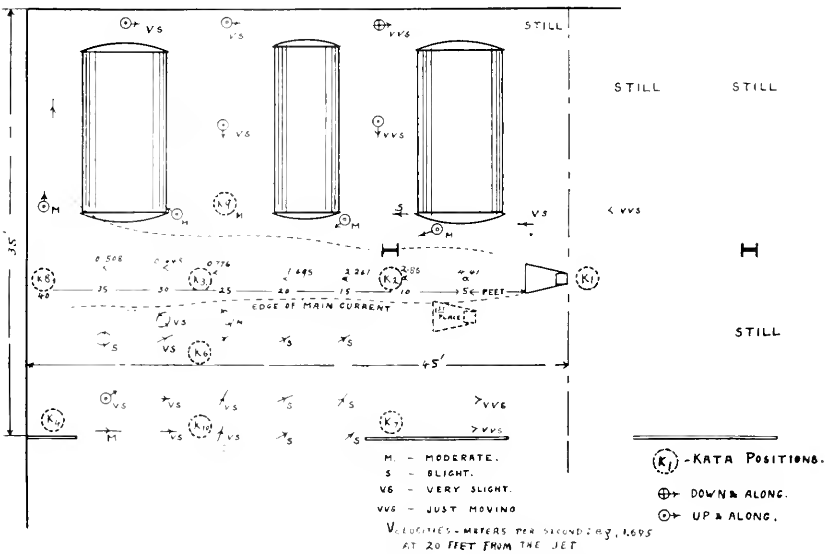

Fig. 8. Effect of horizontal draft in curing shop from a $\frac{1}{2}$ horse power blower drawing fresh air.

Figure 7 shows how one of these jet tubes was set up over the track of a manufacturing process so that it would blow over the heads of two long lines of workers, between whom the articles passed. The effect of the jet tube is compared with that of one of the air trunks already referred to, which was fixed to the wall at the side (Table 1). The jet tube and the air trunk were worked by motors of identical type and power.

Remembering that the dry kata cool- at the head than at the feet: stuffy heads and cold feet are good for no one.

The air used in the jet tube was the warm air from inside the roof of the building untreated in any way; its temperature was 82.5°F., and that of the fresh air from the trunk was 68°F. It will be seen that the warm air cooled the workers more than did the cool air. The negligible effect on the *temperature* caused by the introduction of 1,000 cubic feet per minute of outside air 14.5° cooler than that of the building is

notable. It should also be noted that in some places the trunk produces a large and undesirable cooling power at the feet. (See positions 3 and 7.)

Figure 8 shows the effect of a jet tube working at ½ horse power only, placed in a curing shop for the benefit of the men working in front on three large steam-heated curing pans. The temperature here was generally over 80°F.; the cooling power increases at the various stations are given in Table 2. The temperature of air from the jet tube was from 40° to 50°F.

TABLE 2.—EFFECT OF JET TUBE ON COOLING POWER IN CURING SHOP

Position		Temperature Dry	Temperature Wet	Cooling Power (Dry)	Cooling Power Increase Due to Jet Tube
		°F.	°F.		
K 1	Off	75.0	66.0	3.71	1.09
	On	—	—	4.80	
K 2	Off	79.0	70.0	3.62	8.98
	On	75.0	65.0	12.60	
K 3	Off	77.5	67.0	3.95	2.35
	On	77.5	65.5	6.30	
K 4	Off	78.0	68.5	3.50	1.05
	On	76.5	67.5	4.55	
K 6	Off	—	—	3.21	0.25
	On	—	—	3.46	
K 8	Off	76.0	67.0	3.85	1.17
	On	78.0	68.0	5.02	
K 9	Off	82.0	70.0	2.24	0.26
	On	84.0	70.5	2.50	
K 10	Off	80.0	69.0	3.21	1.09
	On	81.0	69.0	4.30	

The air movements were investigated by means of smoke clouds, and their directions and comparative velocities are indicated on the plan shown in Figure 8. The jet was 8 feet above the floor, and it will be seen that it caused a marked general movement of air in the building. The effect of the jet tubes can be varied to suit prevailing conditions by controlling the speed of the fan motor and by altering the inclination of the jet to the ground.

Conclusions

The following summarizes the results obtained in the eighteen months during which this research was carried out.

Maintenance of Equable Temperatures in Hot Weather.—The introduction of fresh air by centrifugal fans in quantities sufficient to keep down the temperature of a large factory appears to be difficult and costly. In all possible cases ample roof and side openings should be made, and in most cases they should be so arranged that they can be closed completely in cold weather. Side and roof openings should be of approximately equal area, and the ratio of their sizes to that of the building which they are to ventilate, should depend upon the nature of the work that is to be done in the building.

The following appear to be suitable opening figures for buildings of the class under consideration:

Building and Nature of Work	"O" = (Opening Figure sq. ft. × 1000) / (cu. ft. content)
Offices	3.0
Laboratories	4.5
Chemical laboratories	5.0
Light manual work on cool processes	5-6
Light manual work with moderate heat	6-7
Heavy work with great heat	9-11

Many more data of opening figures in well ventilated and badly ventilated buildings are required. The actual air flow through roof and side openings, due to a known difference of inside and outside temperatures, should be determined in perfectly still weather with a view to designing these openings so that a reasonable temperature difference will never be exceeded when all are open. In this way the air changes due to natural ventilation in hot, still weather may be determined, and this would enable the sizes of suitable propeller type fans to be determined for those buildings in which, for any reason, it is impossible to provide the requisite natural ventilation openings. Thus, by observing the heat-induced air changes that take place in a number of naturally ventilated buildings it would be possible to say what fans will be required to maintain an equable temperature in buildings where natural ventilation cannot be used.

The following formula is proposed for use in determining the velocity of air into a building through side openings, and out of it through roof openings of equal area:

$$V = \sqrt{\frac{Ht}{g(H-T)}}$$

Where V = velocity of air in feet per second.
H = vertical distance between centers of roof and wall openings in feet.
t = absolute temperature of outside air.
T = absolute temperature of inside air.
g = 32.2.

Cooling Power.—The cooling power of the air as measured by Hill's katathermometer has an enormous effect upon human comfort. Air movements, drafts, and eddies are great determinants of cooling power.

In cold weather drafts are unbearable; in hot weather they are a godsend, and instead of popularly being called drafts are spoken of as "fresh air," whether the air is fresh or merely the air of the enclosure in a state of movement.

In order to get the best working conditions in a factory it is necessary to give proper attention to the movement of the air around the occupants, and to vary this to suit the climatic conditions.

THE INFLUENCE OF BENZOL UPON CERTAIN ASPECTS OF METABOLISM*

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Introduction and Historical

That benzol (benzene, C_6H_6) is a substance which warrants a more complete study as to its pharmacological and toxicological action is being emphasized by the increasing reports in the literature, not only of Europe, but also of America, of cases of both acute and chronic poisoning which frequently terminate fatally. In Europe, especially in Germany, benzol has long enjoyed an extensive use in the industries, particularly in the manufacture of rubber goods, in dry cleaning, and in the preparation of quickly drying paints because of its powerful solvent action and its quick evaporation. From time to time one finds reports in the literature of both acute and chronic poisoning, and its action on the blood has been noted and thoroughly discussed.

Up to 1914 benzol had practically little use in the United States. Petroleum-benzine and naphtha had been used as solvents in the rubber industry, for they were much cheaper than benzol. With the outbreak of the Great War in 1914, however, two things were brought about:

1. The supply from Germany not only of benzol but also of aniline, which had become a valued ingredient of compound rubber, was shut off.

2. A sudden demand was created for benzol and toluene for the manufacture of explosives, and for aniline for the manufacture of dyes as well as of rubber. As a result, coke by-product plants were erected to secure benzol and toluol. With the armistice there came a sudden cessation of the manufacture of explosives and, with it, a need for new markets for the enormous quantities of coal-tar distillates (benzol among them) which were thrown back on the hands of the producers. These markets have been found in the rubber industry, especially for tires, footwear and hose; in sealing mixtures for tin cans; in the shoe trade for cement; in certain processes in the making of straw hats; as a solvent for fabrikoid; and as a substitute for gasoline in motor car fuel. Benzol is therefore much cheaper now than the solvents previously used and, being also a more powerful solvent, is replacing those previously used. Indeed, it is not improbable that the coal-tar distillates will soon supplant the petroleum distillates in the making of spread rubber goods and dipped rubber goods as they have in Europe.

In America, before 1914, Selling(1) reported a few cases of chronic benzol poisoning from a can factory where rubber dissolved in benzol was used as a sealing fluid. At that time no cases of severe acute benzol poisoning were on record, but in 1915 to 1916 Alice Hamilton(2) reported fourteen cases of sudden acute poisoning with seven deaths, and since that time the danger of such an accident has become familiar to engineers, chemists, and safety experts. The danger of chronic poisoning is less well-

*The data are taken from a thesis by Dr. Benedict R. Harris presented in candidacy for the degree of Doctor of Medicine, Yale University, 1922. Received for publication Nov. 20, 1922.

known and, inasmuch as it is becoming an increasing menace in this country, it is essential that the medical profession should better acquaint itself with the conditions under which it may be looked for, its warning symptoms, its pharmacological, pathological, and toxicological effects. It was with the intention of endeavoring to add a little more to the knowledge of its toxicity that this study of the effect of benzol upon certain aspects of metabolism was undertaken.

Acute Benzol Poisoning

In 1912, the reports of the German factory inspectors (3) contain three cases of acute benzol poisoning, two of them fatal. One man was painting the interior of a barrel with benzol tar paint; the other, a worker in a dry cleaning establishment, had climbed into the washing machine which had a little residue of benzol at the bottom. The third, who was in charge of a distilling plant, had neglected to turn on the cold water for condensation, and the fumes that escaped killed him. A similar case was reported by the British factory inspectors (4) in 1918. In America, the earliest instances of acute industrial benzol poisoning seem to have occurred in connection with the war industries in 1915 to 1916, the men being pipe-fitters or workmen engaged in distilling benzol or cleaning tanks (5). In more recent years a decided effort has been made to avoid such accidents, but if a man is susceptible, it takes only a small quantity to poison or even to kill him. Cases of extreme susceptibility to very small amounts of benzol have been reported by Lewin (6), Harrington (7), and others. Rambousek (8) described thirty-four cases, of which twenty-two proved fatal.

Symptoms (9).—In slight cases there is giddiness and a stage of excitement, which, if the vapor is inhaled in quantity, is quickly followed by coma. The skin assumes a somewhat livid appearance, and convulsions or twitchings of the muscles are noticeable.

Pathology.—According to Beinhauer (10), in acute benzol poisoning the blood in the heart and vessels is fluid, the veins of the abdomen are engorged. There are hemorrhages into the gastric mucosa, bloody foam in the air passages, no benzol odor, and no benzol demonstrable chemically. Sury-Bienz (11) found conspicuous bright red spots over the body, the blood fluid and dark, petechial hemorrhages into the gastrointestinal mucosa and pleura, general venous congestion, and bloody mucus in the air passages. Lehmann (12) of Würzburg, experimenting with cats, found a decided variation of susceptibility in individuals but all of them showed signs of irritation of the mucous membranes, muscular twitchings, and a fall of body temperature. In large doses there were convulsions, narcosis, very deep respiration, first quick then slow, quickened pulse, and death from respiratory paralysis. In man, 15 mg. (1/4 grain) per liter of air produces listlessness and confusion after half an hour, and exposure to from 20 to 30 mg. (1/3 to 1/2 grain or from two to three parts per 100,000 of air) for a few hours may cause loss of consciousness.

Chronic Benzol Poisoning

Santesson (13) in 1897 reported nine cases of chronic benzol poisoning in young women, aged 15 to 20 years, employed in a velocipede tire factory in Upsala, using benzol rubber cement. Four of them died after exposure for

three weeks to four months. Selling (1) in 1910 described similar intoxication in girls aged 14 to 16 years, employed in a Maryland can factory, in which the sealing mixture consisted of rubber and resin dissolved in commercial benzol. In 1916 McClure (14) reported a case from the same factory, and two more cases were reported in the same year, one in a boy aged 17, the other in a woman aged 57. Harrington (7) of Boston reported five cases with three deaths in an automobile tire factory. Two fatal cases were brought before the New York State Workmen's Compensation Commission (15) in 1920. These men had been engaged coating fabrikoid with a mixture consisting of nitrocellulose, pigment, castor oil, grain alcohol, benzyl, and ethyl acetate.

Symptomatology. — Briefly, chronic benzol poisoning takes the form of an aplastic anemia with subcutaneous hemorrhages and bleeding from the mucous membranes as terminal changes. Cases are all so similar that the symptoms and pathology may best be illustrated by the report in full of one of Selling's (1) cases.

Case 1.—M. W., white, female, aged 14 years. Occupation: factory hand.

The patient was first seen by Dr. Girdwood about June 1, 1909. At that time he was treating the mother for pneumonia and his attention was called to the daughter incidentally by her marked pallor and by the presence of a purpuric eruption. She was feeling perfectly well. Shortly after this she began to have haemorrhages from the mouth and nose, and she was advised by Dr. Girdwood to enter the hospital.

She was admitted to the Johns Hopkins Hospital on June 28, 1909, complaining of "spots on body and dizziness."

Family History.—One uncle died of tuberculosis.

Past History.—Negative except for mumps, chicken-pox, and two attacks of measles. She had been working in the canning factory for about four months at the coating machines. During this period she had no symptoms whatever and stopped work because of her mother's illness.

Present Illness.—The patient dates the present illness from the latter part of May, 1909, about one month before admission, when she first noticed blue spots on her arms and legs. These, she states, came out slowly and a few at a time. Shortly after this, she began to have bleeding from the gums, nose, and throat, one attack of epistaxis lasting two days. A few days before admission there was a very severe haemorrhage from the throat, controlled only with difficulty by local applications. For the past week she has been in bed, the chief symptoms being weakness and dizziness. There have been no joint pains and no gastro-intestinal symptoms.

Physical Examination on Admission.—Patient is a well-built, well-nourished girl. Skin shows a marked waxy pallor, and mucous membranes are very pale. Scattered over the arms and legs, and, to a less extent, over the trunk are purplish-red to blue macules, which are 1 to 3 mm. in diameter and which do not change on pressure. Several fading spots are present on the face. On the right shin there is a large ecchymosis and a similar, but smaller one, on the left shin. The gums show slight bleeding, especially about the root of a broken tooth. They are not spongy. In the region of the left tonsil and the right anterior pillar and extending up to the uvula is a dark brown necrotic looking mass surrounded by an inflamed border. This was the site of a severe haemorrhage which had been controlled by the application of ferrous sulphate before admission. No glandular enlargement.

Heart.—Negative except for systolic murmur over the precordium, which was considered of hemic origin. Lungs negative.

Abdomen.—Liver edge easily felt 2 cm. below costal margin in right mammillary line; edge sharp and soft. Spleen not felt; dulness not increased. No oedema of legs.

Ophthalmoscopic Examination.—Moderate grade of neuro-retinal oedema. Fundi very pale and flecked throughout by great numbers of haemorrhages, linear and round. These are especially numerous about the discs. The arteries are extremely pale. The veins are pale but relatively darker than the arteries.

For the first few days after admission the patient was listless, but, in spite of the marked anaemia, her condition seemed very good. There was a continuous, but slight oozing from the mouth and throat, with an occasional expectoration of a blood clot. A

few fresh purpuric spots appeared, some of them on the gums.

On July 3, the patient became very toxic. She was in a state of stupor from which she could not be aroused. The pulse was small and weak. Because of the seriousness of her condition, a transfusion of [illegible] was attempted, following which the pulse became fuller and of a better quality, and the mucous membranes of a slightly better color. There was, however, no change in the [illegible].

July 4. The condition was much improved. The patient was mentally clear. The pulse was slower and of better quality. The improvement continued until July [illegible] when she lapsed back into the [illegible] state. The respiration was rapid [illegible] the pulse rapid and of poor quality. She became steadily weaker until the [illegible] on that day.

During her stay in the hospital the temperature ranged from [illegible] F., the pulse from [illegible]. Blood culture and Widal negative.

The urine was normal [illegible] following the transfusion [illegible] and a few hyaline and granular casts. There was no evidence of hemolysis [illegible] in the color of the urine [illegible] of jaundice.

Blood on Admission.—The examination of the fresh blood showed the red cells smaller than normal, pale and with very pale centres; moderate anisocytosis [illegible] extremely large or small forms. No [illegible]. Marked leucopenia with [illegible] nuclears.

	R.B.C.	W.B.C.	Hb.	
June 2[illegible]	——	[illegible]	2[illegible]	[illegible]
July 1	[illegible]	[illegible]	[illegible]	
July 3	[illegible]	[illegible]	—	
July 4	[illegible]	[illegible]	[illegible]	

In all the fresh smears [illegible] platelets were practically absent. Coagulation time [illegible] minutes.

Differential count of smears made July [illegible]:

Ehrlich's triacid stain

Polymorphonuclears	[illegible]
Lymphocytes	[illegible]
Large mononuclears	[illegible]
Unclassified	2%

[illegible] cells were counted [illegible] seen; no normoblasts.

Contraction of the Blood Clot.—The blood drawn from the ear and [illegible] in a tube for 24 hours showed [illegible] contraction of the clot and expression of the serum. The extent of contraction, however, and the amount of serum expressed were distinctly less than in the control tubes taken from normal patients.

Autopsy (abstract by Dr. W. G. MacCallum). Anatomical diagnosis: Purpura haemorrhagica (probably toxic): haemorrhages in the skin, viscera, and serous surfaces; pallor of the organs.

Muscles a deep red color. Blood pale and watery. The heart muscle, and to a less extent, the liver, show some fatty degeneration.

Bone Marrow.—The bone marrow of the femur is fairly consistent; it is of a dull ochre yellow color with no abundance of bloody supply. It does not look like a markedly hyperplastic marrow.

Microscopic Report.—Malpighian corpuscles of the spleen show areas of hyaline necrosis. Otherwise the findings simply confirm the gross description.

Bone marrow, microscopic examination by Dr. Boggs. Smear from the femur marrow (Romanowski stain) shows very few cells of any kind. The predominant cell is the normal red, which is pallid and slightly basophilic and shows no great irregularity. Leucocytes are extremely scanty. They are mostly of the lymphocytic or myeloblastic type. They are characterised generally by a very definitely reduced chromatin in the nuclei. Many nuclei show vacuolization and the cytoplasm is thin, fragile and poorly stained. One megalokaryocyte seen on fairly careful examination of the cover slip. Suggests an aplastic bone marrow.

The most remarkable feature was the blood condition and this can be described as an aplastic anemia. In common with the aplastic anemia were:

1. Presence of only slight changes in the appearance of the red blood cells (slight pallor and slight anisocytosis).
2. Absence or comparative fewness of regenerative forms.
3. Scantiness of platelets.
4. Diminution of the granular types of white blood cells with a relative increase in the mononuclear element.
5. Marked leukopenia.

Santesson (13), experimentally in rabbits, by subcutaneous injection and by wrapping the bodies of the animals in cloths soaked with benzol, produced chronic poisoning and pathological find-

ings similar to those reported in the foregoing case.

Later researches of Selling (1) and those of Duke (16) show that there is:

1. A direct destruction of leukocytes with reduced formation of new elements.

2. A destructive action on blood platelets and on the megakaryocytes of the marrow from which platelets are formed.

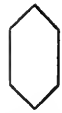
3. Destruction of adult red corpuscles and the prevention of the formation of new ones.

These changes occur in the order given, the effect on the red corpuscles being especially characteristic of very slow poisoning, the last to appear, and the last to disappear with recovery.

Hektoen (17), Rusk (18), and Weiskotten and his colleagues (19) have done much further work, showing a decrease of antibody, hemolysin and precipitin production and exact blood changes. Practically all the work thus far has been done with particular emphasis on the blood system or on the pathological findings. Aside from the work of Sohn (20) in 1913, in which the excretion in the urine of neutral sulphur, urea nitrogen and ammonia nitrogen was studied, the influence of benzol upon metabolism has not been given much attention. It was with the idea of studying the metabolic effects more thoroughly that the present investigation was undertaken.

Chemical Composition of Benzol

Before taking up the experimental work a few words as to the chemical nature of benzol will not be out of place. Three substances are to be considered—benzene, benzol, and benzine. Benzene is a definite chemical substance with the formula C_6H_6.



The term benzol is used in two senses, first as a synonym for benzene, and, second, to designate a variable mixture derived from the distillation of coal tar. The fractional distillation of coal tar yields primarily four products.

1. Crude naphtha distilling below 180°C.

2. Dead oils or creosote oils distilling from 180° to 270°C.

3. Green or anthracene oil distilling above 270°C.

4. Pitch, the residue.

It is from the first fraction that commercial benzol is obtained by redistillation and purification. The benzols of the market vary widely in composition according to the source from which they are derived and the extent of purification. In general, they consist chiefly of benzene and its homologues (toluene, $C_6H_5CH_3$, and xylene, $C_6H_4(CH_3)_2$) and small percentages of other substances. *Benzine*, with which these two substances have been confused, is a derivative, not of coal tar, but of petroleum, consisting chiefly of hexane, C_6H_{14}, and heptane, C_7H_{16}. Usually it contains no benzene, C_6H_6.

Practically all that is known of the pharmacology of benzol is that it is partly oxidized in the body to phenol (15 to 30 per cent.) catechol and quinol, and excreted as phenol sulphates. A part is changed to muconic acid, and a considerable portion is excreted unchanged by the lungs.

Experimental

Methods.—The experiment was divid-

ed into three main parts, in which the following were investigated:

A. The influence of starvation upon urinary composition.

B. The influence of benzol upon urinary composition.

C. The influence of benzol upon blood elements.

(Parts B and C were concerned with benzol administered subcutaneously.)

Healthy male rabbits which had previously been well fed on a mixed diet were used in this investigation. Urinary excretion was divided into twenty-four hour periods for five days by emptying the bladder by pressure upon the abdominal wall. Three rabbits were used in the investigation of the influence of starvation upon urinary composition and eight rabbits, which had previously been starved for twenty-four hours, were used in the investigation of the influence of benzol upon urinary composition and upon blood elements. Water was given, *ad libitum*. The benzol was administered subcutaneously in the groin, mixed with equal parts of cottonseed oil, aseptic precautions being taken. The dosage was 2 c.c. of benzol per kilogram of body-weight. At twenty-four hour intervals blood was drawn from an ear vein and counts made of the number of red and white blood corpuscles. All blood counts were made with a Leitz Hemocytometer, with Neubauer ruling, certified by the American Bureau of Standards.

The following urinary constituents were determined:

1. Total nitrogen.
2. Creatinine (preformed).
3. Creatine.
4. Phosphates.

In addition, the following were also noted:

a. Weight.
b. Fluid intake.
c. Urine output.
d. Specific gravity.
e. Reaction to litmus.
f. Presence of albumin.
g. Reduction of Benedict's solution.
h. Titratable acidity.

All the determinations were made according to the methods as set forth in Underhill's "Manual of Selected Biochemical Methods."

1. Total nitrogen—Kjeldahl method.
2. Preformed creatinine — Folin's colorimetric method.
3. Creatine—Folin-Benedict method.
4. Phosphates—Titration with uranium acetate.

The Influence of Starvation upon Urinary Composition

Typical analytical data are summarized in Table 1.[1] It can be seen from these data that under ordinary starving conditions, only water being given, the following changes in urinary composition are effected:

1. There is a gradual but progressive increase in the amount of total nitrogen excreted.
2. Creatine, which is present in but very small quantities at the beginning of starvation, rapidly increases in amount as starvation progresses.
3. The elimination of creatinine remains fairly constant, decreasing slightly as inanition progresses.
4. There is at first an increased elimination of phosphates followed after the second day by a progressive decrease.

The Influence of Benzol upon Urinary Composition

The following results were obtained:

[1] Illustrative data only are given both here and later. Additional experiments confirm these figures throughout.

1. There was a gradual decrease in weight.

2. The water intake varied, being usually high in the first day of starvation and then gradually diminishing.

TABLE 1.—THE INFLUENCE OF STARVATION UPON URINARY COMPOSITION

Rabbit H: Weight 2.0 kilos.

Day	Fluid		Urine			
	Intake	Output	P_2O_5	Creatinine	Creatine	Total N
	c.c.	c.c.	mg.	mg.	mg.	mg.
1	400	500	275	89	15	270
2	600	575	315	86	18	690
3	530	515	340	83	26	727
4	520	430	237	64	27	826
5	280	210	262	63	40	795
6	290	155	225	41	45	855

3. The output varied considerably with different rabbits, following no fixed rule.

4. The specific gravity varied inversely with the amount of water intake.

5. In all instances the urine was acid to litmus.

6. The presence of albumin varied; in some rabbits it was absent, and in others it was present in varying degr

7. In no case was there a positive reduction of Benedict's solution.

8. The titratable acidity showed but little variation, being quite acid in all cases.

9. The elimination of phosphates varied. In rabbit C there was a progressive increase until death. In all the other cases there was a steady decrease either with or without a primary increase.

10. Creatine elimination increased very markedly within forty-eight hours after the injection of the benzol, being followed by a sharp fall and then a beginning increase again. In rabbit C there was a marked progressive elimination of creatinine, reaching 276 mg. before death on the fourth day of the experiment.

11. Preformed creatinine showed but little change except as noted in the foregoing.

12. Total nitrogen elimination followed fairly closely the elimination of creatine but did not increase to so great an extent.

The analytical data are summarized in Tables 2 to 5.

TABLE 2.—THE INFLUENCE OF BENZOL UPON URINARY COMPOSITION AND BLOOD ELEMENTS

Rabbit C: Adult male; weight 1.9 kilos.

Day	Fluid		Urine									Blood	
	Intake	Output	Specific Gravity	Reaction	Albumin	Reduction	Titratable Acidity	P_2O_5	Creatine	Creatinine	Total N	Red Blood Count	White Blood Count
	c.c.	c.c.					c.c.	mg.	mg.	mg.	gm.		
1	170	136	1.019	acid	trace	0	34.4	333	47	119	1.884	5,232,000	3,900
2[1]	150	195	1.020	acid	trace	0	29.6	382	88	187	3.000	5,000,000	4,600
3	160	220	1.019	acid	trace	0	32.5	429	66	220	2.745	6,400,000	4,700
4	145	145	1.020	acid	trace	0	2.5	630	48	276	2.520	6,000,000	2,400

[1]3.8 c.c. benzol in cottonseed oil injected subcutaneously.

The Action of Benzol upon Blood Elements

In all cases the end results were the same, that is, all rabbits showed a leukopenia of varying degree. The red blood cell count showed but little variation. In all but one rabbit (that is, in seven) there was at first an increase in the number of white blood corpuscles which was very transitory, however, and was followed by a rapidly progressive leukopenia.

TABLE 3.—THE INFLUENCE OF BENZOL UPON URINARY COMPOSITION AND BLOOD ELEMENTS

Rabbit D: Adult male; weight 2.5 kilos.

Day	Fluid		Urine									Blood	
	Intake	Output	Specific Gravity	Reaction	Albumin	Reduction	Titratable Acidity	P_2O_5	Creatine	Creatinine	Total N	Red Blood Count	White Blood Count
	c.c.	c.c.					c.c.	mg.	mg.	mg.	gm.		
1	275	220	1.010	acid	0	0	43.2	450	40	85	0.985	4,960,000	6,800
2	200	200	1.011	acid	0	0	44.0	520	33	108	1.140	5,520,000	6,300
3[1]	200	200	1.015	acid	0	0	49.6	480	79	116	1.440	5,630,000	12,500
4	140	116	1.017	acid	0	0	40.0	340	84	137	1.660	5,340,000	6,500
5	125	125	1.020	acid	0	0	42.4	334	82	112	1.404	4,896,000	4,600
6	115	100	1.026	acid	0	0	36.8	320	21	108	0.879	4,768,000	3,100

[1] 5.0 c.c. benzol in cottonseed oil injected subcutaneously after two days' starvation.

TABLE 4.—THE INFLUENCE OF BENZOL UPON URINARY COMPOSITION AND BLOOD ELEMENTS

Rabbit E: Adult male; weight 2.16 kilos.

Day	Fluid		Urine									Blood	
	Intake	Output	Specific Gravity	Reaction	Albumin	Reduction	Titratable Acidity	P_2O_5	Creatine	Creatinine	Total N	Red Blood Count	White Blood Count
	c.c.	c.c.					c.c.	mg.	mg.	mg.	gm.		
1	300	150	1.015	acid	0	0	36.8	260	20	103	1.072	5,800,000	6,000
2	300	260	1.012	acid	0	0	47.1	234	47	105	1.994	5,560,000	8,400
3[1]	270	230	1.014	acid	0	0	46.8	279	107	103	1.836	5,620,000	5,500
4	260	200	1.018	acid	0	0	40.0	342	157	108	1.296	5,642,000	5,800
5	225	225	1.015	acid	0	0	45.8	342	19	107	1.188	5,480,000	4,900
6	140	110	1.018	acid	0	0	28.8	234	36	104	0.884	5,540,000	4,000

[1] 4.3 c.c. benzol in cottonseed oil injected subcutaneously after two days' starvation.

GENERAL DISCUSSION

That benzol has a deleterious effect on metabolism is readily apparent from the sharp rise in the elimination of both creatine and total nitrogen following its injection subcutaneously into the animals used in this investigation, as contrasted with the slow gradual rise seen

under conditions of ordinary inanition. The interpretation of this rise, especially of creatine, leads one immediately into a controversy which at present is far from being settled. Almost innumerable investigations with respect to creatine have been undertaken, mostly in the last two decades, and the interpretations of results obtained vary.

TABLE 5.—THE INFLUENCE OF BENZOL UPON URINARY COMPOSITION AND BLOOD ELEMENTS

Rabbit F: Adult male; weight 2.2 kilos.

Day	Fluid		Urine									Blood	
	Intake	Output	Specific Gravity	Reaction	Albumin	Reduction	Titratable Acidity	P_2O_5	Creatine	Creatinine	Total N	Red Blood Count	White Blood Count
	c.c.	c.c.					c.c.	mg.	mg.	mg.	gm.		
1	260	180	1.010	acid	0	0	10.4	160	8	106	0.884	5,860,000	5,900
2	300	200	1.015	acid	0	0	18.4	220	26	71	0.860	6,000,000	7,900
3[1]	120	100	1.010	acid	0	0	10.4	146	61	67	1.204	5,946,000	5,300
4	140	100	1.018	acid	0	0	2.4	180	174	69	1.296	5,647,000	4,300
5	90	46	1.026	acid	0	0	10.4	140	30	81	0.784	5,842,000	3,100
6	100	46	1.022	acid	0	0	10.8	120	26	85	0.760	5,872,000	2,400

[1]4.4 c.c. benzol in cottonseed oil injected subcutaneously after two days' starvation.

Briefly reviewing some of the more recent and important work of creatine the following theories and explanations are offered. Underhill and co-workers (21) in 1916 carried out a series of experiments in rabbits and, as a result, concluded that "there is a definite interrelationship between acidosis and creatine elimination. Creatine in the urine may prove to be an index of a condition of acidosis in the organism." Later they state that "creatinuria may occur in states of acidosis when carbohydrate deficiency is not involved and creatine may also be present in carbohydrate deficiency even in the absence of acidosis." Mendel and Rose (22) in 1911, in a series of experiments on rabbits, conclude that: "An increase in the output of creatine is always accompanied by an increase in total nitrogen elimination. This parallelism is ascribed to a common source, namely, *true tissue* or *endogenous metabolism;*" and that "an increased formation of creatine occurs when the tissue catabolic processes are accelerated." In all events, practically all other investigators are agreed that creatine is an index of endogenous metabolism.

Conclusions

Benzol acts not only on the blood elements but exerts a catabolic influence on body tissues as a whole, as manifested by a sharp rise in creatine and total nitrogen, within a very short period after its subcutaneous injections into rabbits, far in excess of that found in rabbits under similar conditions under ordinary starvation.

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THE THERAPEUTIC USE AND TOXICITY OF PICRIC ACID: WITH A REPORT OF TWO TOXIC CASES*

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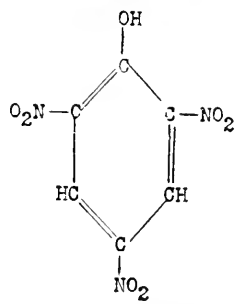
AT the present time, picric acid is one of the most common therapeutic agents for the local treatment of small superficial burns. Despite its almost universal usage, it has enjoyed the reputation of being comparatively nontoxic. Its chemical structure and the nature of its pharmacological action obviously offer possibilities of its detrimental behavior under certain conditions, as illustrated by the two cases reported herein.

PROPERTIES AND THERAPY

Picric acid is a yellow, bitter, odorless, crystalline solid. It is very easily formed from phenol, being the most important nitrophenol derivative. Officially it is known as trinitrophenol; the chemical synonyms are nitrophenic and carbazotic acid. As the structural formula indicates it is a tetra-substitution product of benzene (1).

Trinitrophenol



One gram of trinitrophenol dissolves in 78 mils of water, 12 mils of alcohol, 35 mils of chloroform, and 65 mils of ether (2). Hence the commonly employed saturated aqueous solution is of 1.2 per cent. strength, while with alcohol as the solvent, its concentration is increased about 6½ times. The saturated aqueous solution (empirically known as trinophenon) is acid to litmus, the acidity of the phenols being increased by the introduction of the nitro groups.

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The use of picric acid internally in the treatment of trichinosis and malaria is devoid of any merit. Braconnet in 1830 was responsible for its introduction for the treatment of intermittent fever. Although possessing vermicidal capabilities against tapeworm and roundworm, yet its toxic properties, when given *per os*, contraindicate its use for this purpose (3). The average dose is 0.03 gm. (½ grain). The practical value of picric acid therapy in medicine lies wholly within its sphere as a local agent.

Although used to the greatest extent for burns and scalds of the first and second degrees, it has been advised for a number of skin affections. Wilcox (4) recommends it very highly in the treatment of various skin diseases, especially acute eczema, intertrigo and herpes labialis. By some it is used as a dressing for superficial wounds, likewise for ulcers with free discharge, because of its astringent and antiseptic action. In local hyperidrosis of the feet it is a standard remedy in the form of a 2 per cent. dusting powder.

Chéron in 1876 first suggested the surgical application of picric acid, his contentions being corroborated by Curie and Vigier in 1877. For surgical purposes the saturated aqueous solution is preferable. In diseases of the skin, gauze moistened with the solution may be applied, or the solution may be painted directly over the lesion. A hydroalcoholic menstrum should be employed only in certain selected cases where the epidermis is unbroken. In superficial burns of the hands or feet the extremity may be completely immersed in the solution for two to three minutes, and then the gauze dressing placed in apposition with the affected area. This latter measure is employed by quite a number of industrial concerns, some of which place buckets of trinophenon throughout the works, so that the employees' first emergency measure, in case of a superficial burn of the extremities, is to resort to the picric acid tank. If blisters occur, they should be punctured, the serum expressed, and then the picric acid solution applied; the superficial epidermis should not, however, be removed. Hare (5) recommends the utilization of comparatively small sections of the moistened lint or gauze, since it is more easily removed in this form than in one large piece. In moderate burns the dressing is allowed to remain in place until healing is complete. In burns of the second degree the original dressing may be removed after three or four days, and the wound will often be found to be healed into a clean, soft scab. If the gauze adheres to the scab it should be moistened with the picric acid solution. When unhealed portions still remain, the gauze dressing, moistened with trinophenon, should be renewed. As a matter of fact, most of these cases are ambulatory patients, who continue working; because of the nature of their work, the dressing becomes grossly soiled, and as a rule it is advisable to renew it every twenty-four hours, rather than to leave it in place until healing is complete.

Ehrenfried (6) very concisely and accurately describes the local action of the picric acid as follows:

> Over any clean denuded surface it forms a protective, aseptic scab, by coagulation of the secreted serum, which seals up ruptured lymph-spaces, protects exposed nerve-endings, and splints the wound in such a fashion that epithelial proliferation may proceed rapidly beneath, simulating Nature's method. This artificial scab protects against infection from external sources and promotes rapid and painless epidermatization.

At first the solution may cause some pain, which is slight and of the smarting character. More often, however, it

is absolutely painless, but in all cases it speedily becomes anesthetic by virtue of its protective properties explained in the foregoing. The burned area rapidly becomes coated with the thin, very light yellow pellicle of coagulated protein.

The phenol coefficient of picric acid is 6 (Tidy (7)), so that 0.165 per cent. picric acid is equivalent in antiseptic strength to 1 per cent. phenol. Chemically this could be foretold, since it is a recognized fact that the introduction of the nitro group into the phenols increases their antiseptic action (8). According to Ehrenfried, a saturated aqueous solution destroys the Bacillus pyocyaneus in less than one minute, and Staphylococcus pyogenes aureus in two minutes, while in the experiments of Schamberg and Kolmer (9) it showed itself four times as active as phenol. Hence the utilization of picric acid as an antiseptic in burns is rational therapy.

The Toxicity of Trinitrophenol

Rapp and Föhr (1827) first investigated its toxic action on dogs. More recently Koizumi (10) has described its poisonous action on dogs and rabbits. In Ehrenfried's review of the literature, he notes that there never has been reported a fatal case of picric acid poisoning.

Taken internally it is absorbed probably as the sodium salt. The picric acid is reduced in part to picramic acid ($C_6H_2(NO_2)_2NH_2OH$) by the liver and other portions of the body. This is simply another of the many detoxicating properties of the liver. It is eliminated chiefly through the urine to which it imparts an intense yellow color, although later the urine may be colored a peculiar red (Walko, 1901) or reddish brown. After a single dose of 1 gm., the excretion of picric acid may continue for a week (11).

Trinitrophenol and its salts have a tendency to decompose the elements of the blood and to produce methemoglobin. With toxic doses it causes in the lower animals a destruction of the red blood corpuscles, but this phenomenon is rare in man; Adler in 1880 reported one instance of toxic anemia. A leukocytosis may or may not be concomitant.

The affinity of picric acid for albumin is accentuated in an acid medium, consequently it readily unites with acid tissues. This phenomenon explains the selective localization of necrotic foci in trinitrophenol poisoning. The reduction of picric acid to picramic acid is a detoxicating one, inasmuch as picramic acid does not so readily form the protein salt (12). After large doses the skin and mucous membranes, including the conjunctiva, are stained more or less yellow—the so-called "picric" jaundice; this icteric tint is actually due to the staining of the epithelium by the acid. Chéron reports an instance where the application of 0.45 gm. (6.9 grains) to the vagina produced yellowness of the skin in an hour; the patient also suffered from symptoms referable to the nervous and digestive systems (13).

The physiological dose is ½ grain, while doses from 15 to 30 grains are decidedly toxic (Lewin, Adler). The symptoms of poisoning are referred to either the gastro-intestinal, nervous, circulatory, or urinary system, or more commonly to several of these locations. Depending on the degree of the toxicity the gastro-intestinal symptoms vary from a mild anorexia, dyspepsia and flatulence to a severe diarrhea accompanied by gastrodynia, abdominal cramps and emesis, the vomited matter being stained yellow. The irritant action of picric acid on the mucous membranes is re-

sponsible for the gastritis found. The nervous manifestations vary from a slight headache and vertigo to stupor, with convulsions, followed by collapse in the extremely severe cases. Picric acid is a respiratory and cardiac depressant, but symptoms referable to these systems are rare. Adler notes, however, a primary tachycardia with a subsequent slowing of the pulse rate. Occasional symptoms are strangury and anuria. Asthenia and fever may accompany the foregoing constitutional manifestations of internal picric acid poisoning.

As stated previously, the yellow pigmentation may ensue upon internal administration, but superimposed upon this may be an erythema or even a generalized eruption of eczematous character and itching in nature. Sollmann calls attention to the fact that the dermatitis may simulate a measle rash (14).

In chemical and dye works picric acid may be classified under the industrial poisons, since inhalation of the dust causes an irritability of the respiratory tract, coryza, sneezing and inflammation of the buccal mucous membrane (Spruit). Among workers engaged in the manufacture of high explosives, picric acid may be the etiological factor in many cases of occupational dermatoses. The appearance, symptomatology and course of this dermatitis sometimes bear a marked resemblance to ivy poisoning, both of these affections being classified dermatologically as venenatous. This ensuing dermatitis is often quite severe and is extremely resistant to treatment, being accompanied at times by some of the constitutional symptoms already enumerated. At this point it should be remembered that after local application of trinophenon over extensive burned areas sufficient quantities may be absorbed to produce constitutional effects.

A Report of Two Toxic Cases

Ehrenfried treated 300 cases of small superficial burns without any symptoms of absorption. In over 100 cases of industrial burns similarly treated by the writer, there were no toxic developments, except in the two cases cited here. In all but these two instances the saturated aqueous solution of picric acid was the medicament employed. These patients were the first to be treated with a newly replenished supply of picric acid solution. The saturated aqueous solution was the strength ordered but, as subsequent investigations disclosed, the drug supplied by the pharmaceutical concern was a saturated solution of picric acid in a 10 per cent. alcoholic menstrum. As stated previously, the solvent power of alcohol for picric acid is $6\frac{1}{2}$ times as strong as that of water, hence this solution (10 per cent. alcohol) contains proportionately over $1\frac{1}{2}$ times as much solute as the trinophenon (saturated aqueous solution). A further deleterious effect of this preparation is that the alcohol facilitates the absorption of the picric acid.

Case 1.—A. J. G., a plumber, aged 34, had a contact burn of the second degree over the volar surface of the left forearm. The size of the burned area was 2 by 3 inches. After the part had been cleansed of dirt, strips of sterilized gauze soaked in the hydro-alcoholic picric acid solution were applied. Over the gauze was placed a light covering of dry absorbent cotton, held in place by means of a light bandage. Two days later the patient returned for redressing, the original dressing being soiled externally. At this time the burn, although not healed, was clean, free from infection and apparently progressing nicely. A second picric acid dressing was applied. Three days later the patient experienced the first subjective symptoms of burning and moderate itching under the bandage. Examination revealed an acute inflammation of an erythematous nature, limited to the outline of the yellow-stained area of contact of picric acid. On the succeeding or sixth day

after the first application, numerous vesicles appeared which in some areas were agglomerated, and in some cases coalesced. There was considerable local edema about the reddened area. This acute stage lasted for four days, the only constitutional symptoms being a headache and an annoying insomnia. The itching during this period was almost unbearable. By the tenth day of the dermatitis calorica the acute lesions had involuted to an erythemato-squamous type, accompanied by considerable thickening and possibly infiltration of the skin. This stage was not unlike an eczema. This condition was somewhat resistant to therapy but in two weeks more the area was clean, with only a few crusts and scales remaining.

Case 2.—F. H. B., a boilermaker, aged 27, came in contact with a hot fire door, and received a second degree burn over the antero-lateral aspect of the right thigh. The burn covered an irregular area of approximately 10 square inches, surrounded by occasional spots of vesication. The blisters were punctured and the same treatment employed as in Case 1, with renewal of the dressing on the second day following the accident. Four days later the stained area presented the same weeping erythemato-vesicular picture as in the previous instance. This stage was very transitory. The actual region of the burn appeared raw and irritated. At no time throughout the course of the dermatitis was the patient subject to any symptoms other than those relative to the burn itself. The lichenification in this patient was more pronounced than that in the patient in Case 1. Complete recovery occurred four weeks after the date of the accident.

Therapy.—The treatment followed was identical with that employed in cases of acute eczema. The affected areas were given a preliminary bath with *sapo mollis* and water. Removal of the excess picric acid was attempted by washing with saline solution followed by hydrogen peroxide. This was not so effective as successive spongings with alcohol as the solvent, followed by saline. Some authors have recommended lithium carbonate solution (1 dram to 1 quart of water) for removing picric acid stain from the skin, but this preparation is practically never found in the emergency hospitals maintained by industrial concerns. During the acute "weeping" or vesicular stage, the medicament should be of the nature of a clear lotion. The author employed compresses saturated with aqueous boric acid, advised by Lane (15) in the treatment of ivy poisoning. With the subsidence of the moist character of the lesions, powder mixtures and ointments are applicable. Aristol (di-thymol di-iodide) was used because thymol has the reputation of causing a dry scaly skin to become more moist; but this therapy was replaced by the boric acid ointment, which proved more successful. It is needless to say that the lesions were necessarily free from infection, before the aristol powder and boric acid ointment were applied.

Discussion

It is quite evident that these cases of poisoning did not occur because of the slight excess of picric acid in the 10 per cent. alcoholic solution, but rather because of the increased absorption rate of such a preparation. It is for this reason that the employment of alcohol in any amount is discouraged as a solvent for picric acid solution to be used locally. A common formula for the preparation of such a solution has been:

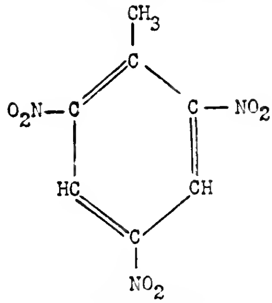
℞

Acidi picrici	ℨ ii
Alcoholis	℥ iss
Aquae destillatae	O ii

An interesting fact was the lack of constitutional symptoms of any great degree. This is comparable to the dermatitis accompanying trinitrotoluene poisoning, the presence and severity of which bears no relation to the constitutional symptoms, although trinitrotoluene and dinitrobenzene (another similar agent) are absorbed mainly through the skin. The dermatitis occurring from

the application of picric acid in solution is much more acute than the dermatoconiotic type following contact with picric acid dust by workers. This latter is similar to trinitrotoluene dermatitis,

Trinitrotoluene

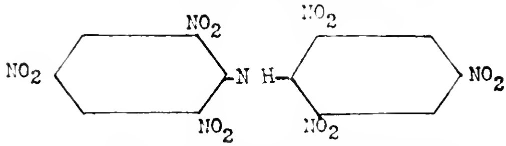


a common affection during the recent war (16).

Sequeira (17) reported many cases of dermatitis due to hexanitrodiphenylamine, a component of the explosive material found in bombs. This dermatitis, appearing about nine days after exposure to the irritant, presented dysidrotic vesicles and a yellow staining of the skin.

It is quite conceivable that here we have an example of the relation of

Hexanitrodiphenylamine



chemical structure to pharmacological action. The similarity of the skin lesions is in accordance with the chemical groupings. It is noted that there is a preponderance of the nitro groups in all three chemicals—trinitrophenol, trinitrotoluene, and hexanitrodiphenylamine; hence we may readily presuppose that this is the toxophoric radical. Trinitrotoluene is almost identical with trinitrophenol, except that there is a methyl radical in place of the hydroxyl group, thereby increasing the toxicity.

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THE EFFECT OF ANILINE BLACK DYEING ON FACTORY WORKERS*

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THE Factory Department of the Home Office, London, in the summer of 1921, decided to review the question of the effect of aniline black dyeing on the workers, and it was found necessary to have blood examinations made. I was invited to carry out this part of the investigation, and the following paper deals with the results of the blood examinations and the conditions found at the different works.

PROCESSES

Aniline black dyeing is not a direct process like the dyeing of other aniline colors. Although there are several direct aniline black dyes on the market, the only method of producing a satisfactory aniline black is by an indirect method, the dye being actually manufactured on the cloth during the process. This end is attained by the oxidation of an aniline salt by sodium chlorate or sodium bichromate in the presence of some metal compound which acts as an oxygen carrier, such as copper sulphate or a ferric salt.

During the present investigation three different processes of aniline black dyeing were investigated: (1) the one bath process (hot and cold); (2) the steam process; and (3) the oxidation process.

The One Bath Process (Hot and Cold).—This method is used chiefly for yarn dyeing. The goods to be dyed are allowed to stand for about half an hour in a cold bath containing a solution of aniline hydrochloride and sodium bichromate; the bath is then brought to the boiling point and is kept at this temperature for half an hour. The material is then washed, soaped, sized, and dried.

The Oxidation Process.—This process is sometimes termed the copper sulphate method. The chemicals required are: an aniline salt, an oxidizing reagent (such as sodium chlorate), an organic acid (such as acetic or tartaric acid), and copper sulphate. The part of the process concerned in the production of aniline black may be subdivided into (*a*) mixing, (*b*) preparing, (*c*) aging, and (*d*) chroming, washing and drying.

Mixing is the preparation of the "liquors" through which the material to be dyed is run in the impregnating machine. Two liquors are prepared: the aniline liquor which may be made from aniline hydrochloride, but which is more commonly prepared on the premises by a combination of aniline oil and hydrochloric acid; and the bluestone liquor which contains copper sulphate and the other ingredients.

Preparing includes impregnating or padding and drying. The liquors are mixed and carried by hand or by pipes to an impregnating machine. This machine consists of a trough for the solution, and rollers that mangle the material, which then passes over drying cylinders to the "ager."

The ager is a closed chamber which can be heated to 110° to 120° F., or more. The material passes through it, over a series of rollers, and oxidation

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begins when the cloth is dry. The room may be fitted with doors and windows and corridors so that the material running through may be observed. Experience shows that the formation of aniline black takes place best in a damp atmosphere, and a little water vapor is therefore admitted. The chemical reactions which take place are very complex and not fully understood, but some vapor of aniline is evolved and it is almost impossible to prevent some of the vapor from escaping into the surrounding room at the places where the cloth enters and leaves. The ager need be entered only in the case of a breakdown or for the purpose of cleaning.

Chroming, or fixing, and drying complete the process.

The Steam Process.—This process is also known as the prussiate, ferrocyanide or Prud'homme method. It is employed in printing as well as in dyeing loose cloth because, though slower than the oxidation process, it is more under control, and the black is said to be more durable. As far as this investigation is concerned, the essential parts of the process are mixing, preparing, and steam aging.

The mixing is similar to that in the oxidation process, except that the ingredients of the second liquor are different. Preparing is also carried on as in the oxidation process. Aging is done in a steam ager, in contradistinction to the ager, or dry ager, of the oxidation process.

The steam ager is a chamber enclosing a series of rollers over which the material runs. It can be tightly closed, after which steam is admitted, arrangements being made inside so that condensation does not occur on the material. The ager has to be cleaned periodically and has to be entered in the event of a breakdown; in either case the steam is first turned off. The chemical reactions which take place are again complex; steam and aniline fumes may escape at the mouthpiece, at leaky joints, and at the ends of the rollers.

Chroming, washing, and drying complete the process as in the other methods.

Symptoms of Poisoning

The cases of aniline poisoning met with were all mild ones, the chief signs being pallor, blueness of the lips, ears and nails, with occasionally a blue line along the edge of the gums, tremor and dyspnea. The patients complained of lassitude, loss of appetite, nausea, dizziness, headaches, shortness of breath, and a feeling of weakness in the lower limbs. The appetite was generally very fickle, and it seemed to be a recognized practice for the men to take their meals when they felt inclined. Another common symptom which the men described was that on leaving the works "the air seemed too strong for them" and "caught them in the legs."

No acute cases of aniline poisoning were met with, although several such cases were described as having occurred in the past, usually as a result of some aniline oil having been spilled over a workman, as in a case described by Prosser White and Sellers (1).

Changes in the Blood

An examination of blood counts taken at the various works showed that they fell into two distinct groups. In Group 1 all the red cell counts were over 5,000,000 corpuscles per cubic millimeter; while in Group 2 most of the red cell counts were below 5,000,000 corpuscles per cubic millimeter. A

[illegible]	[illegible]	[illegible]	[illegible]
Average blood count	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

hird group included the blood findings n three cases of aniline poisoning in men who were engaged in the manufacture of aniline oil; an opportunity for examining them occurred on an occasion when their symptoms justified the appointed surgeon to the works recommending that they should be taken off the particular work on which they were engaged. They are included here for comparison with the cases met with in he aniline black dyeing works.

In Group 1 there was no count which vas not within normal limits, and the nly sign noticed in any of the men was slight pallor, except in Cases 2 and 3 where the lips and ears were of a bluish tint. The average blood count of the ses in Group 1 serves as a convenient andard for comparison with the cases Group 2 and Group 3 (see Table 1).

The most striking difference between e first and second groups is the difference in the percentage of hemoglobin. Group 1 there are only two cases here the percentage of hemoglobin is low 90, while in Group 2 there are only o cases where the percentage of hemoglobin is over 90. The lowest percentage of hemoglobin met with was 71, but six cases in Group 2, and in all the ses in Group 3, a brown pigment was und in the blood which made it impossible to estimate the percentage of emoglobin correctly. In four out of ese nine cases the pigment was sufficiently marked to be obvious to the naked eye when the patient's ear was ecked, and it was well demonstrated placing a drop of the patient's blood white blotting paper beside a drop normal blood. In the other cases the gment was not so obvious until coal as was passed into the diluted blood order to prepare it for comparison ith the Haldane standard tube; this made the brown pigment more obvious. Where the brown pigment was observed, the blood was examined spectroscopically but methemoglobin bands were not detected. The brown pigment observed in these cases is generally stated to be due to methemoglobin, and failure to detect it is ascribed to the fact that it is present in a lower proportion than 1 in 10 of oxyhemoglobin. Malden (2) failed to detect it in his cases, and it was not seen in the blood of the case described by Prosser White and Sellers (1). Curschmann (3) states that he has repeatedly been able to observe methemoglobin bands in cases of aniline poisoning when the hemoglobin content had fallen below 70 per cent., though even then only as a faint shadow.

It is doubtful whether or not the brown pigment seen in these cases is methemoglobin. In experiments on aniline poisoning in rabbits, Price-Jones and Boycott (4) observed two abnormal pigments in the blood: "(*a*) a brown pigment without any spectroscopical characters; (*b*) a pigment, probably brown, which shows a band in the red, but which is not methemoglobin." The nature of the brown pigment found in the blood of cases of aniline poisoning needs further investigation.

There are twenty-three cases in Group 2 and in fourteen of them the red cell count is below 5,000,000 corpuscles per cubic millimeter, the lowest being 4,164,000. In Group 3 two out of the three cases have a red cell count of less than 5,000,000 per cubic millimeter. Examination of the stained films showed a wider variation in size in Groups 2 and 3 than in Group 1, but the alteration in size was not very great. In Table 1 no note on variation in size has been made because it was hoped that it would be possible to measure the corpuscles, but

circumstances prevented more than a few measurements being made. Two hundred red blood corpuscles in cases 17, 18, 19, 20, and 21 from Group 2 were measured, and the average size was found to be 7.2μ, 6.9μ, 6.8μ, 7.3μ and 6.5μ, with a variation in size from 4.5μ to 9μ. Normal red cells average 7.4μ in diameter, and vary in size from 6μ to 8.75μ. No variation in shape was noticed in any of the groups.

Malden (2) states that "6 out of 13 [cases of aniline poisoning] showed basophil granulations in the red corpuscles. The number of cells affected varied from 2 or 3 in the whole film in the slight cases to 10 or 13 in every field of the microscope in the more pronounced ones. This reaction is of great significance, as it appears to be in aniline poisoning, as it is in lead poisoning, the earliest noticeable sign in the blood." In the present investigation only three cases, numbers 31, 32, and 33 in Group 2, showed any punctate basophilia, and in these cases only two punctate basophilic cells were seen in each film. Polychromatophilia was rather more common, but it was never very marked, only three or four such cells being seen in a film.

With regard to the leukocyte and the differential counts, no definite conclusion can be drawn. The counts in Group 3 seem to suggest that in the more severe cases there is a slight leukopenia and a slight relative increase in the lymphocytes.

A study of the cases in Groups 1 and 2 shows that in the anemia found in aniline black dyers there is:

1. A decrease in the hemoglobin content;

2. In some cases an alteration in the blood pigment;

3. A decrease in the number of red cells per cubic millimeter;

4. A lower color index;

5. In some cases slight alteration in the staining properties of the red cells;

6. Little alteration in the leukocyte count;

7. Little alteration in the differential count.

The chief changes in the blood condition are the diminution in the amount of hemoglobin and the formation of some other hemoglobin compound, probably of a more stable nature than oxyhemoglobin—changes which cause some degree of oxygen deficiency. The symptoms met with are those of oxygen deficiency. Following the change in the hemoglobin content there is a fall in the number of red blood corpuscles per cubic millimeter, which, though never very marked, is quite definite.

Conditions Found at the Different Works

One Bath Process: Group 1

Works 1.—The average number of hours worked per week for August and September was thirty. Mixing was done in a barrel in the same department in which dyeing was carried on. Water was added first, then hydrochloric acid, and then aniline oil.

Dyeing was done in a Klauder Weldon dyeing machine. After the machine was filled with the solution, the yarn was put in; it was first worked in the cold, then steam was applied and a curtain drawn down at the sides. There was no locally applied exhaust ventilation.

The manager of this works remembered one case of aniline poisoning which occurred in a man who had wiped up some aniline oil which had been spilled, and in this way got his skin and his clothes saturated.

CASE 1.—This man, a mixer of aniline and chrome, aged 44 years, had been an aniline black dyer for twenty-six years. Except for slight pallor, no signs nor symptoms of poisoning were observed. He said that he had never been affected by aniline, and that he wore rubber gloves when mixing.

CASE 2.—This patient, a dyer, aged 56 years, had been engaged in this work for twenty-one years. He displayed slight pallor, and his lips and ears were slightly blue. He said that he had never been affected by aniline, but that he had seen men faint in summer and have to be carried outside.

CASE 3.—This man, a dyer, aged 22, had been engaged in this work for six years. He was slightly pale, but he presented no other signs nor symptoms. He said that he felt faint and dizzy in hot weather.

Works 2.—The average number of hours worked per week for two months previous to inspection was thirty-six; but during the fortnight previous to our examination the number had been fifty-three per week.

Mixing was done in a corner of one department, not in the main department. There was no local exhaust ventilation. Aniline oil was put in first, then hydrochloric acid and water. The two liquors were conveyed to a tank near the dyeing machine, and thence by a pipe to the machine. There were two dyeing machines in a separate department from that in which mixing was done, and without locally applied ventilation.

CASE 4.—This man was a general mixer, aged 39 years, who had worked as an aniline black dyer for eighteen years. (The actual mixing took about one hour a day.) He displayed slight pallor, and slight tremor (he was a heavy smoker). He said that he had had no symptoms of aniline poisoning. When he was mixing, he always wore gloves.

CASE 5.—This man, aged 32 years, had worked as a dyer for eight years. The only symptom was slight pallor; he complained of no ill effects.

CASE 6.—This man, aged 43 years, had worked as a dyer for eight years. He displayed no signs nor symptoms of poisoning.

Works 3.—The number of hours worked per week averaged thirty-six for the year.

Mixing was done in tubs placed in a corner of the dyeing department. Water was put in first, then aniline oil, and then hydrochloric acid. The actual mixing took only about one hour a day.

Dyeing was done in the same department with mixing. The solutions were carried in buckets to the dyeing machine and were all mixed in it. There were two dyeing machines which were enclosed, and each had a chimney to the outer air. The steam was mostly diverted into the chimneys and little came out at the sides of the machines. The men did not stand near the machines when they were in action.

CASE 7.—This man, a mixer of aniline and chrome, aged 37 years, had worked at this occupation for fifteen years. His color was good. He said that he occasionally felt dizzy and drowsy, but that he had noticed no loss of appetite nor gastric disturbance.

CASE 8.—This man was a washer and carrier of solutions. He was 51 years of age, and had worked at this occupation for twenty-six years. He showed no signs nor symptoms of poisoning.

Steam Process: Group 1

Works 4.—The average number of hours worked per week was sixteen.

Mixing was done in a receptacle in the open air. Water was put in first, then hydrochloric acid, and then aniline oil.

Impregnating and drying were done in a lower department where the final mixing of the aniline solution with the other ingredients was made. The drying cylinders were under a hood and fan, and the cloth passed directly from them to the ager.

Aging was done in an upper room, which was connected with the preparing

room by a stairway. The steam ager was ventilated by a chimney opening into the outer air. It was entered about once a month, when there happened to be a breakdown, and on Saturday for cleaning, in preparation for which it was opened on Friday and allowed to cool.

Case 9.—This man was a mixer and supervisor, cleaner of ager and chromer. He was 44 years of age, and had worked for five years in his present position. The symptoms observed were pyorrhea alveolaris, blue discoloration of the gums, slight pallor, lips and ears blue, and fingers cold. He said that he had occasional headaches, and felt drowsy in hot weather.

Case 10.—This man was a mixer, impregnator and chromer, aged 71 years, who had been engaged at his present work sixteen and a half years. His teeth were defective, and there was a blue discoloration of the gums, but no obvious pallor.

Case 11.—This man, an impregnator, aged 61 years, had been employed at his present work for six years. He had no teeth; his face was gray, and there were prominent veins on his nose. He complained of occasional headaches and dizziness.

Works 5.—In this plant the average number of hours worked per week was seven.

Mixing was done in the open air, the aniline oil being put in first. The impregnating and drying machines were in one department. The dyeing solutions were ladled out of a tub into the trough of the impregnating machine. This machine was under a hopper with a chimney for exhaust. The drying chamber containing the drying cylinders was also ventilated by a hopper and chimney. The ager was in a separate department.

The manager called our attention to the danger of "firing," which sometimes occurs after printing and before aging, when the cloth has become too dry on the drying cylinders. The cloth then burns, giving off aniline fumes. One man, who had left the company's employ before this investigation, came in contact with these fumes, vomited, became dyspneic, and had to stagger out into the open air where he recovered in about twenty minutes. He was not cyanosed.

Case 12.—This man, aged 32 years, had worked two years as a mixer. He gave no signs nor symptoms of poisoning.

Case 13.—This man, aged 26 years, had worked three years as an ager since the war, and five years as an impregnator previous to the war. He displayed no signs nor symptoms of poisoning. He said that he cleaned out the ager weekly but was never affected by it.

Case 14.—This man, aged 27 years, had been in charge of the drying chamber for two years. He displayed no signs nor symptoms of poisoning.

Case 15.—This man was a "tenter in," aged 16 years, who had worked at this occupation for one year. There were no signs nor symptoms of poisoning.

Case 16.—This man, a "plaiter out," aged 16 years, presented no signs nor symptoms of poisoning.

Steam Process: Group 2

Works 6.—The average number of hours worked per week was thirty.

Mixing, preparing, and aging were all done in one department. Mixing was done in a barrel between the impregnating machine and the hot-air chamber, and the hot rollers were above it. There was a cross current of air from windows on each side and exhaust ventilation above. All the steam appeared to rise.

The cloth passed over hot rollers to the hot-air chamber which was exhausted by a fan. It was then transferred to the ager which was ventilated by a chimney in the roof opening into the outside air.

Case 17.—This man was a mixer and impregnator, aged 40 years. He had worked

as a mixer for sixteen years. There was obvious pallor, and his lips and ears were slightly blue. He complained of headache due to fumes, especially when dealing with heavy cloth, and said that he sometimes got dizzy and drowsy in the summer. He said that "aniline catches a man behind the legs and makes him feel weak," but that "an hour in the fresh air cures."

Case 18.—This man, an ager and impregnator, aged 26 years, had been employed at his present work for three years. He said that he was always pale and that his finger tips were always cold. He displayed no sign of poisoning on the day that the examination was made.

Both of these men were working in the same room but while the former showed signs of aniline poisoning, the latter displayed no definite signs. This was in accordance with the conditions found. The former worked for most of the day between an impregnating machine on one hand, mixing barrels on the other, and drying cylinders above; while the latter spent most of his time at the ager at the other end of the room, and was not so much exposed to aniline fumes from the cloth.

Works 7.—The average number of hours worked per week was fifty.

Mixing was done in a separate room and aniline oil was added first. We were told that about eight years before, when there was no exhaust ventilation, the mixer was liable to suffer from aniline poisoning, dizziness, and gastric disturbances. Since that time a hood with a pipe connected to an exhaust fan had been installed, but the action of the fan was weak on the occasion of our visit.

The impregnating machine was worked by two men and the mixer. The machine was under a hood and chimney connected with a fan. There was no need for the men to touch the cloth with their fingers but they put their hands in the trough containing the dye. The cloth passed from the impregnator through a hot drying room, and was then carried to the ager, which was in a separate department and was under exhaust ventilation with a fan.

Case 19.—This man, a mixer and impregnator, aged 54 years, had worked in aniline for twenty-eight years. He was pale, his lips and ears were slightly blue, and his appetite was not very good. He said that he had had headaches and dizziness, and in hot weather had a tired, aching feeling. At his work he wore a leather apron for protection. He took his meals in the mixing room.

Case 20.—This man was an impregnator and drier, aged 49 years, who had been employed at his present work for eighteen years. Except for slight pallor, he displayed no signs nor symptoms of poisoning.

Case 21.—This man, aged 49 years, had been an ager for twenty-four years. He showed slight pallor and slight tremor (alcoholic history), but gave no other signs nor symptoms of poisoning. He said that he was affected only when the fan stopped, as occasionally happened; then he became dizzy and "went off his food."

In this plant, the worker last mentioned was the least affected; he was an ager, working in a separate room and not in such an atmosphere of aniline fumes as that in which the other two men worked.

Works 8.—The average number of hours worked per week was forty-eight.

Mixing was done in the open air, but under cover. Aniline oil was added first in the mixing. The two men who did the mixing wore aprons and leggings of sacking.

Impregnating, drying, aging, and chroming were all done in one department. The two dyeing solutions were mixed by the impregnator, and the impregnating was done in cold liquors. The drying cylinders were under a hood with a duct and fan, and were surrounded by a thick curtain hanging from the hood. The hot-air chamber was entered

only for repairing breakdowns, and then the doors and windows were opened for some time beforehand. The ager had a hood and chimney, and was exhausted by a fan.

Case 22.—This man, aged 49 years, had been a mixer for two years. He displayed slight pallor and blueness of the lips, and complained of occasional dizziness.

Case 23.—This man, aged 59 years, had worked seven years as a mixer. He complained of occasional loss of appetite; otherwise he gave no signs nor symptoms of poisoning.

Case 24.—This man was an impregnator and drier, aged 33 years. He had been engaged in his present work for fourteen years. The symptoms observed were pallor and blueness of the gums. He complained of occasional headaches, and felt drowsy at the time of examination. He said that he ate nothing in the morning until 10 o'clock; then he had a meal by the cylinders.

Case 25.—This man was an impregnator and drier, aged 36 years. He had been employed at his present work for sixteen years. He was pale, but gave no other signs nor symptoms of poisoning.

Case 26.—This man was an ager, 38 years of age, who had been employed at his present work for three years. He displayed slight pallor, and complained of occasional dizziness, drowsiness and loss of appetite, with a feeling of heaviness in the stomach. He said that he had felt better since a fan was installed.

Four out of the five men had mild symptoms of aniline poisoning, and the blood picture was in accordance with the symptoms. It is curious that Case 25 working in the same room as the others and on the same machine as Case 24 should have no symptoms and should have a practically normal blood count, with regard to red cells and hemoglobin.

Oxidation Process: Group 2

Works 9.—The average number of hours worked per week was forty-eight for the month preceding our visit. Mixing was done in a separate department. The aniline oil was pumped into the mixing tank so that it need not be touched by the mixer; the oil was added to the solution last. The other ingredients were kept in a series of tanks and were conveyed by pipes to the mixing tanks. Ventilation was afforded by an opening in the roof. The foreman said that before this system was installed and put in a separate department the mixers suffered from indigestion, blueness of the lips and ears, and faintness.

Impregnating, drying, and aging were done in one department. The manager had just had a hood and chimney put over the impregnating machine. The combined drying cylinder and ager was ventilated by two chimneys leading to the outer air.

Case 27.—This man, a mixer, had worked eleven years in the dye industry. For sixteen months he had worked on the new installation. He gave no signs nor symptoms of ill effects. He had seen men become cyanosed about the lips, especially in summer.

Case 28.—This man was an impregnator, aged 46 years, who had been engaged in his present work for four years. He said that he changed color at times, and that his face was pale and his lips blue. He gave no other signs nor symptoms of poisoning.

Case 29.—This man, aged 40, had worked one year as an impregnator. He had previously been an ager. He was pale and his lips were blue. He said that he sometimes was dizzy and drowsy, but had no gastric trouble. He said that in the past his legs had become tired, and on leaving work the fresh air was too strong for him, especially in the summer. He was previously an ager and entered the ager many times a day. He was under treatment for aniline poisoning at the outpatient department of the local infirmary for thirteen weeks in 1919. He said that he had felt "a different man" since the hood was put up over the impregnator.

Case 30.—This man, aged 38 years, had worked for fifteen years as an ager. The symptoms observed were: pallor, faint blue line along the edge of the gums, and nails rather blue. He said that he had never had headaches, dizziness, or drowsiness.

CASE 31.—This man was an assistant ager, 33 years old. He had been employed for ten years at his present work, but gave no signs nor symptoms of poisoning.

An interesting point arose in connection with Cases 28 and 29. Some time before our visit a plaiter down had been installed on the impregnating machine, and as the two impregnators were working between the impregnating machine and the plaiter down they got all the fumes available. The manager noticed that the men were being affected by the fumes and had the plaiter down removed, and a hood and chimney installed. Since then the men have improved in health.

The other men who had a blood count of less than 5,000,000 (Cases 30 and 31) worked under the cloth passing from the hot rollers to the ager. Neither of them had marked signs nor symptoms of poisoning but the blood count shows that they were being affected by the aniline.

Works 10.—The average number of hours worked per week was thirty-two, but there had been a rearrangement in the staff a few days before our visit; some men were transferred from another works which had closed down, so that although the average number of hours worked per week at this works for a month previously was thirty-two, this does not apply to the men transferred from the other works.

Mixing was done in a separate department ventilated by louvers in the roof. The "bluestone" and "aniline hydrochloride" solutions were run by separate pipes to the barrel near the impregnating machine, and were poured into the padding trough by means of a can. The impregnating, drying, and aging machines were in a large airy department with roof ventilation.

CASE 32.—This man was a mixer, aged 45 years, who had been employed at his present work for eleven years. He displayed no pallor, but said that he got dizzy when cleaning out the tanks.

CASE 33.—This man, aged 43 years, had worked for twenty-five years as a mixer. The symptoms observed were: slight pallor, lips blue, and blue discoloration at the edge of the gums. He said that he got dizzy in close, hot, or foggy weather.

CASE 34.—This man, aged 56 years, had been a mixer for twelve years; he had been at this works for only one week. No pallor was observed. He had dermatitis on the dorsum of the hands, but he said that he had never worked in chrome.

CASE 35.—This man was an impregnator, aged 47 years, who had worked six years as a padder. He had been at this plant only one day. Except for a slight tremor, he displayed no signs nor symptoms of poisoning.

CASE 36.—This man had been an impregnator for ten years, but had been at this plant for only two weeks

CASE 37.—This man, aged 48 years, worked at the drying cylinders. He had been an ager for ten years previously, but had been at this plant only a few days. No signs nor symptoms of poisoning were noted. The man's color was good.

CASE 38.—This man, an ager, 33 years old, had been in this plant only one day. He had previously been employed at the same work, however. Blue discoloration at the edge of the gums was the only symptom noted.

CASE 39.—This man was an ager, 54 years old, who had worked twenty-three years at the drying cylinders and ager. He entered the ager three times a day, and cleaned it every week-end. There was a blue discoloration at the edge of the gums, his teeth were decayed, and he was sweating profusely. No other symptoms were noted.

It is difficult to draw any conclusion from this works because of the recent changes in the workmen employed. It will, however, be noticed that in Cases 34, 35, 36, and 39 there were no definite symptoms of absorption of aniline but that there was a definite change in the blood picture.

Group 3

The men whose cases are included in

Group 3 were employed in an aniline dye works, and at the time of our examination were engaged in the manufacture of aniline oil. These men were under daily observation by the appointed surgeon to the works, who said that they were "nearing their limit" at the time when the blood counts were taken.

Case 40.—This man was a charge hand, aged 36 years. He displayed marked pallor: his lips and ears were blue, but his nails were normal. He complained of frontal headache and of shortness of breath. Three years previous to this examination he was affected with nausea and vomiting due to aniline, and had occasionally to be sent off work for a few days.

Case 41.—This man was a charge hand, aged 34 years. His lips and ears were blue, and there was marked pallor, but his nails were normal. He said that he had had headaches recently, and felt the aniline "going into his legs." He said that he ate when he felt hungry.

Case 42.—This man was 40 years of age. His lips were blue, and his face bluish gray. He had become dizzy after dinner on the day of our visit and had to be sent to the ambulance room. His last attack was two years previous to this examination.

Conclusions

Various opinions are held as to which process of aniline black dyeing is most likely to give rise to aniline poisoning. The number of works visited and the number of workmen examined are too small to allow definite statements to be made; but a few points are rather suggestive.

Three yarn dyeing works were visited and fell into Group 1. As they were working more hours per week than some of the factories in Group 2, it would appear that this process is less liable to cause symptoms of aniline poisoning than are the other two processes.

There is little choice between the steam process and the oxidation process as far as their effects on the workers are concerned.

One factor concerned in the production of symptoms is clearly brought out in Table 1—that is, the time worked per week. Under existing conditions the more the hours worked per week, the greater is the chance of the production of symptoms of aniline poisoning and of anemia.

Two other factors also appear to be concerned—namely, the application of local ventilation in the various parts of each process, and the separation of the various parts of the process in different rooms. The atmosphere in all works where aniline is used contains a certain amount of aniline vapor, as is shown by the discoloration of the woodwork or paper. The amount may be very small, as the same discoloration is noticed in the open air in the vicinity of aniline oil drums or mixing barrels; but in the neighborhood of the impregnating, drying and aging machines the air is more thickly charged with aniline vapor; while in places where steam is used more aniline seems to be carried in the water vapor.

The application of better local ventilation to the various machines concerned should effect an improvement in the health of the workers.

There may be a fourth factor concerned in the production of symptoms, and that is the individual susceptibility of a worker to aniline. In most of the factories someone reported having noticed that some men were more affected by aniline fumes than others. We found no evidence either to support or to disprove this statement.

We found slight symptoms and definite alterations in the blood picture in mixers, impregnators, steam agers and dry agers, but since some men are mix-

ers and impregnators, and others impregnators and agers, it is impossible to say from our present data which part of the process is most concerned with the production of symptoms.

This investigation was made possible through the kindness of Professor Dean, in whose department the laboratory work was carried out and who obtained a grant from the Manchester University to defray expenses. In addition my thanks are due to Dr. Legge, H. M. Senior Medical Inspector of Factories, who kindly placed much information at my disposal; and to Dr. S. A. Henry, H. M. Medical Inspector of Factories, with whom the investigation was made and whose help and advice have resulted in the publication of the preceding notes.

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THE TREATMENT OF CONSTIPATION*

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FEW preventable and curable disease conditions are more common than constipation. Few are more important. Among the effects which may be more or less due to this condition may be mentioned lowered resistance to all infectious diseases, auto-intoxication, many cases of so-called rheumatic pains, neuralgia, headaches and backaches, hemorrhoids, appendicitis, obstruction and inflammation of the bowels, acne, eczema, and other skin diseases. There are, in fact, few pathological conditions in the causation or aggravation of which constipation may not be a factor; yet little serious effort is made by either health authorities or physicians to prevent or to cure this serious condition. It is not to be wondered that patent medicine manufacturers thrive on the sale of laxatives and cathartics. Their preparations offer the public relief equal to that which can be obtained from physicians, in many instances, and often in a more palatable form.

Constipation is commonly treated as if it were a disease in itself. It would be far more logical to recognize it as only a symptom in the vast majority of cases. To regard it thus would lead to a more general realization of the fact that, while some cases are the results of definite organic conditions, most cases are essentially functional, and in reality the malady which demands correction is the far too common one—namely, faulty habits of living. Perhaps this is recognized by physicians. It is contended, however, that the patient demands a pill and, as a living must be made, the pill is supplied. This contention is a double reflection on the one who makes it. It is the duty of the physician to give the patient not what he wants but what he needs. Moreover, most patients appreciate having their false ideas corrected. They wish to be instructed in hygiene—a fact proved by the attitude of patients in industry, by the popularity of the health columns in the newspapers, and by the very lucrative practices which a number of chiropractors have built in Cleveland chiefly by teaching their patients hygiene from the mere smattering which they themselves have gleaned.

All good physicians realize the importance of adopting hygienic measures in the treatment of disease; yet their greatest defect is their inability to teach their patients as much as they intend.

At our plant dispensaries, which serve an average of over a thousand working people, the majority of whom are young women, we have an unusual opportunity for testing the efficacy of hygienic treatment as well as the methods of teaching it, and, judging from results in over 125 cases, we have worked out what appears to be a satisfactory treatment for constipation.

Whenever, either at sick call or in the course of routine examination of employees, we discover a patient suffering from chronic constipation we carefully question him regarding his habits of diet, water intake, exercise, and regu-

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larity in trying to have a bowel movement. Usually this discloses serious faults of living which are probable causes for the condition. It also indicates to the patient that the condition is one of the penalties for his own failure to obey the laws of health.

After the catechism has been completed, the results which may follow continued constipation are pointed out to the patient. With women the great possibility of impairment of beauty by sallowness and the development of skin diseases is stressed, because most women are more easily influenced in this way than in any other, even if they have little beauty to lose. Men are shown that the condition will probably decrease their earning ability and perhaps cause them to lose time from work, at intervals, by lowering their resistance. Every effort is made to show them how this is likely to occur, for without knowing the underlying reasons for these hygienic instructions most persons are unlikely to follow them. Both men and women are reminded that the continued use of drugs will only aggravate the condition.

The next step is also more important than it may seem. The patient is asked whether he will follow instructions if the physician outlines a course of treatment directed toward the permanent cure of the condition. If the preliminary steps have been carefully followed, the patient will usually agree to do so; if not, further effort is made to sell the idea to him. Upon the failure to win an unqualified promise the matter is dropped, with the statement that if the patient will return when he is ready to follow instructions we will give them to him. This occurs rarely, but there is no other course open if instructions are not to be wasted. Those who promise to follow instructions are put upon the following diet which, while simple, apparently covers all the requirements for the conservation of health:

DIET LIST

Green foods: Two or more portions daily

Asparagus, lettuce, spinach, brussels sprouts, rhubarb, endive, beet and dandelion greens, swiss chard, celery, tomatoes, cress, kale, okra, cauliflower, cabbage, green onions, string beans.

Fruits: Two or more portions daily

Oranges, cranberries, berries, peaches, pineapple, melons, apples, pears, apricots, cherries, plums, prunes, grapefruit.

Starches: Not over six portions daily

Potatoes, beets, carrots, turnips, bananas, bread and other foods made from flour, macaroni or spaghetti, rice, cereals.

Proteins: One or two portions daity

Meats, eggs, cheese, hulled beans, peas, lentils.

Water: Eight glasses daily

Milk: Four glasses daily

Sweets: Not over one portion daily

Candy, cakes, cookies, sweet rolls, pies or other pastry, jams and jellies, ice cream sodas or sundaes, etc.

Objections may be made that this diet is unscientific, inasmuch as measurements are inaccurate, calories are not figured, and vitamines are not estimated. These things we admit. The greater part of the population will, however, not learn to measure their food accurately and to compute calories and vitamine content for many years. Meantime the duty of the physician is to teach these people hygiene, not in his language but in theirs. Our diet list represents an effort to translate some knowledge of dietetics into their language. It may be possible that they can follow it and still have an inadequate diet, but it is very unlikely. Our results

demonstrate that it is a great improvement over what many people have been eating.

In the beginning of this experiment patients were merely instructed to have daily two full portions of green vegetables, two portions of any fruit except bananas, which are classed with starchy foods, or berries, which appear to be distinctly constipating, and two quarts of water. This led to some misunderstanding, and when we learned that one patient had stopped eating meat entirely, thinking that we had intended him to do so, we had the complete dietary printed.

Patients are informed that, in addition to following the diet, they should have at least one hour of active exercise daily: that, in order to form a regular habit they should try for ten minutes or more at the same time every day to have a bowel movement, even though they feel no inclination to do so; and that they should never neglect a call to have a bowel movement. It is important that the reason for each provision in the instructions should be explained to the patient so that he may take an intelligent interest in following them. It should also be impressed upon him that he must carry out all instructions in order to be cured.

If the condition is of such long standing that the patient has been in the habit of taking laxatives or cathartics two or three times a week, drugs may be necessary for a short time. We have found only two which are useful. Bitter fluid extract of cascara sagrada is given nightly in doses of 30 drops until the patient has had a movement daily for a week. Then the dosage is decreased 5 drops and the reduction repeated whenever the smaller dose has had the same result for a week. Aromatic cascara is less efficacious. Mineral oil is also useful in some cases; many patients refuse to take it, however, because it feels oily in the mouth. Although phenolphthalein has an effect somewhat similar to that of cascara, we have not used it because it is reported to irritate the kidneys and to cause a skin rash occasionally. In only a very small percentage of our cases, however, was it necessary to prescribe any drugs.

Our first group of fifty-three patients seemed to show remarkable results; most of them were reported as cured when followed up by one of our nurses after periods varying from a few weeks to several months. Later groups checked by other nurses did not show such good results. It was noticeable that the percentage of persons whose condition was improved or who were cured varied with the temperaments of the four nurses. Consideration of this fact has led us to decide not to publish the actual statistics which are probably somewhat inaccurate. This is no reflection upon the nurses to whom much credit is due for following up our cases. Even the group showing the poorest results indicated that less than 25 per cent. of the patients had failed to obtain either a cure or considerable improvement.

Several patients reported after several months that they had had one relapse after obtaining relief, as a result of failure to observe the instructions, but that by again following the plan they had been cured. This suggests that we have succeeded in instilling, in some patients at least, knowledge which will enable them to avoid constipation for some time.

A considerable number of young women, who were anemic as well as constipated and who complained of dizzi-

ness and headaches, reported that these symptoms quickly disappeared after they adopted the diet; when seen after intervals of a few weeks they showed no signs of anemia. In a number of cases of acne, also, marked improvement resulted without other treatment.

Almost universally patients who followed the directions, even in part, reported appreciable improvement in their feelings of well-being, and a number of them, who had been underweight, gained several pounds. The best recommendation for the diet is that results were sufficiently marked in a number of cases to stimulate other employees to apply to us for the diet list.

Conclusions

1. Constipation is too serious a condition to be neglected by physicians.

2. The method of instructing patients is at least as important as the instructions themselves.

3. The majority of cases of constipation in working adults can be cured by dietetic and hygienic measures alone.

JET DUST COUNTING APPARATUS*

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THE apparatus described in this paper was designed by the author in connection with the work of the Advisory Committee on Atmospheric Pollution, which is now attached to the Meteorological Committee of the Air Ministry.

The necessity for some reliable method of estimating the amount and nature of suspended impurity in air became obvious early in the investigation, as a short summary of existing methods will show. An instrument for measuring dust would have many applications, and for estimating the quantity and nature of smoke pollution in the air of cities, the amount and nature of dust in factories, mines and similar places, some means is essential.

The following paper (1) reviews briefly the methods already known and (2) describes an instrument evolved, its development and method of use, together with the principles upon which it is based. A number of methods previously tried are described in an early issue of THIS JOURNAL (1), to which reference should be made for a bibliography of dust measurement.

REVIEW OF METHODS

Impaction Methods.—In these methods dust particles are forcibly directed against surfaces specially prepared with sticky substances, such as glycerine, oil, gum, silicate of soda or resin. The impaction method has been used in different forms and in all cases reliance has been placed upon the sticky substances to bring about the adhesion of the dust particles to the surface. There are serious objections to the use of any such substance, which may be briefly summarized as follows:

The author has tried several experiments with different adhesives, such as liquid paraffin, Canada balsam in xylol, but found that no advantage was gained in this way. In fact, in all cases it was impossible to obtain any great efficiency when such an adhesive was used, since a high velocity in the jet impinging upon the glass surface is essential to efficiency but is incompatible with the existence of a smooth, sticky film at the point of impact; if the velocity is high enough to make the jet efficient, the sticky material is blown away, while on the other hand, if the velocity is low enough to preserve the sticky film intact, the efficiency is so reduced as to make the method useless.

This drawback is illustrated in Table 1, which shows a comparison of the results obtained by the use of a well-known instrument in which a jet, circular in section, is caused to impinge upon a glass surface coated with vaseline, with the results obtained by the instrument devised by the author. From this table it will be observed that the efficiency of the "jet and vaseline" instrument was of the order of 4 or 5 per cent. Clearly, very fallacious conclusions may be drawn from the use of an instrument of this type. It is, however, somewhat difficult to test its efficiency as there is no standard to which to refer.

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Condensation Methods. — Condensation of water on the dust particles is utilized in Aitken's dust counter and the koniscope; a fog is produced which, in the koniscope, is compared with a standard. No distinction is made between dust particles and other nuclei which may be effective in assisting condensation.

Electrostatic Precipitation. — This method has been used to trap the particles by precipitation of dust into a liquid; the liquid is then compared with standard suspensions. If the precipitation is on to a dry surface the amount may be weighed directly, or again an attempt to count the particles under the microscope may be made.

Agitation with Water.—In Palmer's apparatus the air is drawn at high velocity through 40 c.c. of water in a specially shaped vessel; this results in a great disturbance of the water and the production of spray. The loss of water by evaporation is made good from time to time; the water and suspended dust are finally made up to 100 c.c., and 1 c.c. of the dust is counted in a cell, after settlement.

Ultramicroscope. — Attempts have been made to count dust particles by an ultramicroscopic method but the results are not satisfactory; in counts which have been made in this way by the author the number of suspended particles in the air was always less than the number obtained in the jet record.

Settlement.—Methods of dust estimation depending upon the settlement of the particles upon prepared surfaces and a subsequent count of such particles obviously give incorrect results, since they do not measure suspended particles but simply dust which has settled on the plate during a given time. This number need not be even proportional to the amount in suspension, since it depends upon the temperature and degree of disturbance of the air, size, shape and density of the particles, etc.

Owens' Dust Counter

The general principle upon which the jet dust counting apparatus is based depends primarily upon the condensation of moisture on the dust particles in the air, and the subsequent trapping of these particles by the sudden deflection of a fine jet of air which is caused to impinge upon a glass surface. The number and nature of the particles are ascertained by microscopic examination of the resulting dust record.

TABLE 1.—COMPARISON OF RESULTS OBTAINED WITH "JET AND VASELINE" INSTRUMENT AND OWENS' DUST COUNTER

(1)	(2)	(3)	(4)
	Number of Particles per C.C.[1]		Ratio $\frac{(2)\times 100}{(3)}$
Date 1922	Instrument Using Jet and Vaseline	Owens' Dust Counter	(*i.e.*, expressed as %)
Jan. 24	120	5,600	2.14
" "	320	6,100	5.25
Feb. 7	305 (5 c.c. sample)	5,480	5.56
" "	231 (10 c.c. sample)	5,480	4.22
Mar. 1	240	3,950	6.08
" "	210	3,950	5.32
" 10 morning	668 } 657 }	14,050	4.75 } 4.68 }
Mar. 10 evening	348	8,020	4.35

[1]The particles varied in diameter from 1.3 microns down, averaging 0.5 micron.

When air which contains dust and a sufficient quantity of water vapor is suddenly expanded, a condensation of some of the water vapor takes place upon the dust as nuclei. This fact was utilized by John Aitken in his well-known dust

counter (2), in which the air is admitted to a small cell where its pressure is suddenly reduced, with the result that a rain of water drops occurs upon the floor of the cell. The floor is divided into squares and is observed through a microscope placed above the cell; the number of drops which fall upon it can thus be counted. In this case the assumption is that each drop has condensed around a dust nucleus and that a count of the drops is the equivalent of a count of the dust particles. Under these conditions, however, water will condense on nuclei other than dust, and a count of the water drops is, therefore, not to be interpreted as a count of the dust particles. The majority of the dust particles suspended in air are so very minute, averaging perhaps half a micron in diameter, that they cannot be seen except under a high magnifying power, and the construction of the Aitken dust counter does not permit of a high magnification.

In the instrument now to be described the sequence of operation is as follows: A high velocity jet of air is caused to strike a microscope cover glass; the effect of this high velocity is to bring about a fall of pressure in the jet, accompanying which, and resulting from it, is a corresponding fall of temperature. This in turn causes a condensation of the moisture in the air upon the dust particles, which are thus projected wet against the cover glass, and, as the water evaporates, are left behind adhering to the glass.

Experimental Development.—The evolution of this instrument involved a large amount of experimentation, an account of which follows. In the early stages experiments were made with a round jet formed from a piece of drawn and bent glass tubing. This jet was fixed inside a small bottle in such a way that a microscope slip could be held within about 1 mm. of the orifice, so that when air was drawn from the bottle it entered through the jet, impinging upon the glass slide, where some of the dust was found to adhere. This apparatus was experimented with in order to find what the order of its efficiency was, and whether this could be improved by smearing the glass with sticky substances. The percentage of total dust adhering to the glass was not very high, probably about 20 to 30 per cent., and this was not improved by smearing the glass with sticky liquids, such as thick paraffin; the sticky liquids on the slides were blown away from the point of impact of the jet, thus making them ineffective. In any case the amount of dust caught was not sensibly increased by the use of such means. What caused the dust to stick to the glass, became therefore an important question.

In order to investigate this a form of jet was next designed which could be placed upon the stage of a microscope so that the process could be observed while the jet of air was striking the glass surface. A small brass holder was made, the floor of which was formed of a sheet of mica; at a height of about 1 mm. over the mica floor a circular cover glass could be placed and held in position by a screwed sleeve. A side connection to the holder enabled air to be drawn from the cell enclosed between the cover glass and the mica floor. In the mica floor a circular hole about 0.1 mm. in diameter was made; thus, when the jet was placed on the stage of the microscope and light was reflected upwards through the floor of the cell, the objective could be focused upon the cover glass immediately over the hole in the floor. When air was drawn out of the cell by means of a small air pump, or other means, the dust par-

ticles could be seen impinging against the lower surface of the cover glass.

By watching this process carefully it was soon observed that many of the dust particles were surrounded by small drops of liquid. In this way it was discovered that, under suitable conditions, the water in the air could be made to condense upon the dust particles just before they impinged upon the cover glass. In order to cause the jet, air has to be drawn from the cell, and this implies a reduction of pressure in the cell. Again, if the velocity of the jet is high, there is a material fall of static pressure in the jet itself, owing to loss of velocity head. Hence, the conditions are suitable for condensation. If, therefore, the air before entering the jet is saturated with moisture, or so nearly saturated that the reduction of pressure brought about as already described will result in supersaturation, water will be condensed upon the dust particles, and will in most cases evaporate immediately, leaving the particles adhering to the glass surface as the velocity of the air falls off after impact with the glass.

This form of jet was found so extremely sensitive that a small fraction of a cubic centimeter of air passed through the jet produced a rain of dust particles, too numerous to count except in very pure air. Also the record was of very small dimensions and therefore extremely difficult to find unless in the way already referred to, *i.e.*, by focusing first upon the orifice forming the jet and then racking up and focusing upon the cover glass immediately above the orifice. Again, owing to the small quantity of air required to give a record in this form of apparatus, it appeared likely that its use would involve error, as a sample taken might not be strictly representative. The apparatus was, therefore, modified and a form was made in which the orifice for producing the jet consisted of a slot of about 0.1 mm. in width and of any suitable length up to 1 cm., depending upon the size of the cover glass used (see Fig. 1). This form removed the foregoing objections as the quantity of air which could be drawn through the

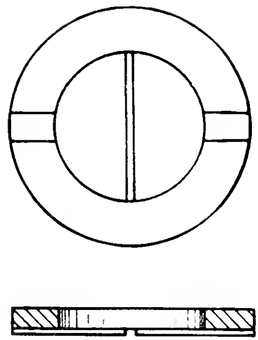

FIG. 1.—Slot 0.1 mm. wide and up to 1 cm. long

jet without obtaining too many dust particles for counting could be greatly increased. Further, there was now no difficulty in finding the record on the cover glass, as the record itself was of linear form extending across the glass, the jet itself being of ribbon shape.

At this stage an attempt was made to measure the efficiency of the apparatus by means of a double jet, the second taking the air which passed through the first. An apparatus was constructed on the lines of that already described so that the operation could be watched under the microscope (Fig. 2). The lower cell had a slot B in its floor, the jet from which struck its roof, which in turn formed the floor of the upper cell and contained another slot A, so that the air having impinged upon its lower surface passed through the second slot and impinged upon the roof of the upper cell.

The construction of an apparatus with slots of this type was found to be comparatively easy in contrast to the construction of an apparatus with a round orifice of very small and fixed diameter. The slots were made in this apparatus by cementing the two halves of a cover glass to a metallic ring, the slot being formed between the two straight edges, which were suitably ground and polished (Fig. 1). The arrangement of the slots was such that they were at opposite sides of the center of the apparatus. If the first jet stopped all the dust, there would obviously be no dust carried through with the second jet and none would be found on the roof of the second cell. Tested in this way it was found that a varying percentage of the total dust was trapped, sometimes 100 per cent., and at other times perhaps 50 per cent.

This method of testing the efficiency is not really satisfactory as it is possible that particles which escaped the first cell may escape the second. Again, as the adhesion of the particles is due to water condensation, the first cell may remove a sufficient quantity of the water from the air to reduce the efficiency of the second cell.

It appeared probable that variations in the quantity of dust trapped might be due partly to variations in the moisture contents of the air, as well as to change in dust contents; therefore a dampening chamber was devised through which the air had to pass before entering the jet. This chamber had its walls lined with damp blotting paper and was so arranged that the air would have to spend a certain minimum time in it before entering the jet.

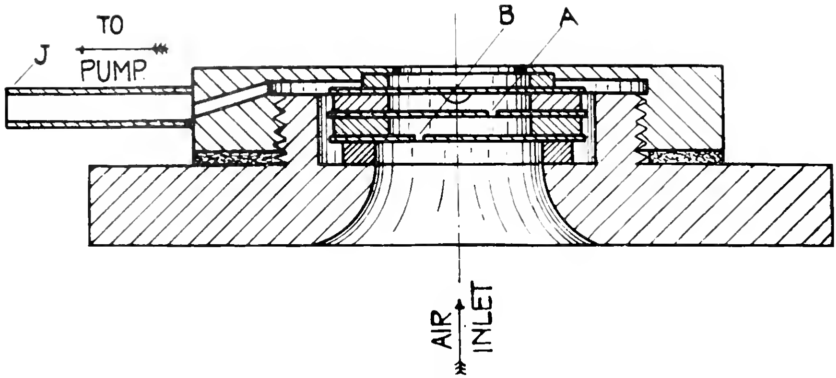

Fig. 2.—Double cell.

The use of this damping chamber was found to make the records much more consistent, and, from recent results with the double cell method, it appears probable that all the dust in the air is trapped, or at least that the amount escaping is a negligible quantity. An attempt was made to measure the efficiency by means of an ultramicroscopic method, in which the number of particles suspended in the air was counted under a microscope while brightly illuminated against a dark background, and was

compared with the number obtained with a jet record. This method is very difficult to apply and is subject to great error owing to the extremely small volume of air used in the ultramicroscopic count. In all tests made so far, however, the number of particles counted ultramicroscopically was always less than that counted in a jet record. This is a result which might have been expected, since the visibility of the particles when examined in suspension in this way is a function of the intensity of the illumination and is also affected by the continuous brownian movements.

On December 1, 1921, a record taken by the jet gave 11,300 particles per cubic centimeter, and an ultramicroscopic count at the same time gave only 4,400. An interesting point to observe as bearing upon visibility of small particles is that the number of particles in the above record over 0.85 micron was approximately 3,500 per cubic centimeter. It must be remembered that while in the jet count a 1/12 inch objective was used, in the other a 2/3 inch objective was used, as it is not possible to use a high power for the ultramicroscopic count.

On January 22, 1922, during a bad fog in London, a count of a record taken by the jet gave 21,760 particles per cubic centimeter, while an ultramicroscopic count gave 18,870. There was an abnormal number of large particles during this fog, and it was observed that particles which settled to the floor of the cell used for ultramicroscopic count were approximately 0.5 to 0.9 micron in diameter, as measured under a 1/6 inch objective. A serious drawback to the ultramicroscopic method is the extremely small volume of air which is examined. In the case referred to, the actual volume in which the particles were counted was approximately 1.6 c.mm.

Perhaps the most satisfactory test of the efficiency of the jet was made with the aid of an instrument which the author had previously designed for the purpose of measuring the pollution of city air by smoke. In this instrument a measured volume of air is drawn through white filter paper of such texture that the suspended impurity is trapped and remains as a discoloration upon the surface. When air which had been passed through the jet apparatus was subsequently drawn through a white filter paper in this instrument, it was found that no discoloration was produced, while a similar volume of air which had not been passed through the jet gave a distinct discolored spot on the filter paper.

Present Instrument.—An instrument was designed for general use, as illustrated in Figures 3 and 4. The apparatus consists of a sleeve B, open at the top and bottom and screwed internally for the reception of a piece K, which forms a screwed plug. This is perforated by a central hole for admitting air to a narrow slot A, formed diametrically across the hole by means of two semicircular metallic plates, which are held in position by a ring R attached to the plug K. The upper surface of this ring is recessed to form a bed for a microscope cover glass, and the ring R under the cover glass is of such a thickness that when the cover glass is placed in position in its recess it forms the roof of a cell about 1 mm. high; the floor of the cell is formed by the above-mentioned metallic plates, the function of which is to form between them a narrow slot, approximately 0.1 mm. in width. The center of the ring R is turned out to a suitable diameter which in practice is found to lie between 2 and 10 mm.; the diameter of the central opening in this ring

also determines the size of the cell included between the cover glass and the metal plates forming the slot. The length of the slot A is also determined by the diameter of the opening in the ring, or of the central opening of the plug K.

Into the upper opening of the sleeve B fits a screwed plug C, to the inner end of which is fixed a three claw spring by which the cover glass is held firmly upon its bed, when the plug C is screwed home.

Between the plug C and the sleeve B, a leather washer H is provided, by means of which an air-tight joint is made when the plug C is screwed home. The sleeve B has an annular recess formed in its inner wall between the inner ends of the plugs C and K, and communicating with this recess is a connection E, for attachment to an air pump. Suitable channels X are formed in the upper surface of the ring R which receives the cover glass, as shown in Figure 4, so that when air is drawn from the space between the plugs C and K, by means of an air pump attached to E, a jet of air is caused to enter the slot A and impinge upon the cover glass, escaping to the annular space in B and the connection to the pump E, by means of the channels X formed in the upper surface of the ring R.

An approach tube, or chamber, T, is screwed to the plug K, as shown, and lined with absorbent material, such as blotting paper, held in position by suitable fastenings. During use the absorbent lining is wet with water, and its function is to supply moisture to the air before it enters the jet A. The capacity of this approach tube, or damping chamber, is two or three times that of the air pump attached to E.

When the apparatus is in operation, an ordinary hand air pump of a measured capacity per stroke is fixed to the connection E. In practice 50 c.c. capacity is found suitable, but this may be varied if desired. In taking a record of the dust the procedure is as follows:

After the air pump has been attached to the connection E, a few strokes of the pump are made so that the damping chamber T is filled with the air to be tested. The plug C is then removed rapidly and a carefully cleaned cover glass placed in position upon the ring R; after this has been done the plug C is replaced rapidly and screwed home. The pump is then operated so that one or more volumes of air are drawn through the jet A, a suitable interval being allowed to elapse between each stroke of the pump to permit the air in the damping chamber T to absorb water from the lining. The plug C is then removed, and the cover glass may be dropped out on to the hand by inverting the instrument.

The jet of air entering through A and striking the cover glass deposits its dust thereon. The cover glass may then be mounted for microscopic examination of the particles.

Method of Mounting Records.—The most convenient method of mounting records has been found to be as follows: Slides are prepared ready labelled, upon which are fixed tin rings of the diameter of the cover glass, that is, about 2 cm., a central cell of a little over 1 cm. being left. The rings are fixed to the slides by means of a special adhesive, which also coats the upper, or free surface, of the ring and which has the property of remaining sticky for several weeks. This adhesive is prepared from a mixture of resin and liquid paraffin. The rings are dipped in the melted mixture and placed upon the slide.

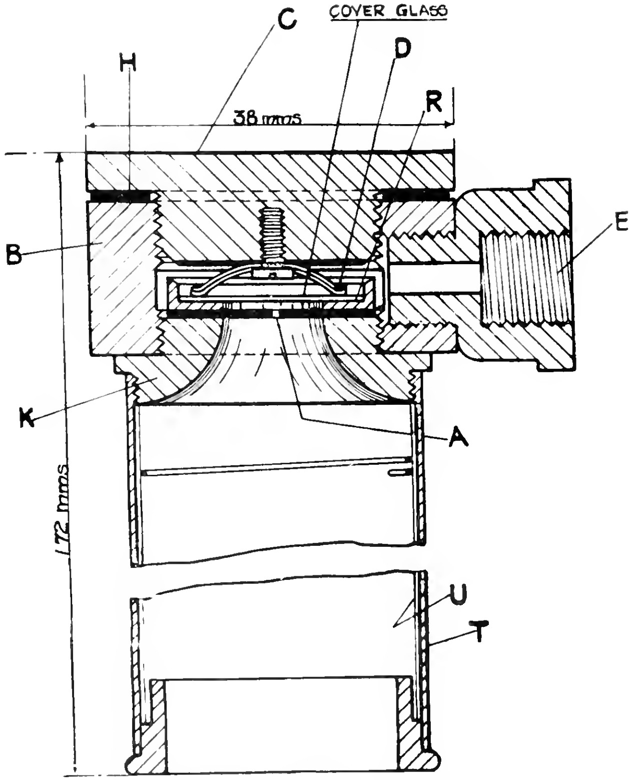

FIG. 3.—Vertical section of apparatus.

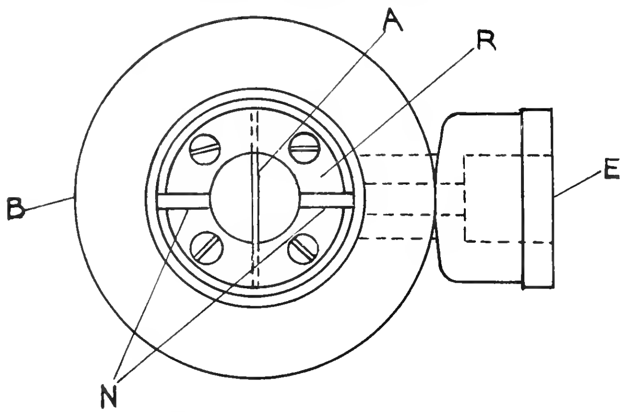

FIG. 4.—Plan of apparatus with top plug removed.

When it is desired to mount a record the cover glass is placed with the record downwards upon the top of the ring and pressed down gently with the thumb. The heat of the thumb is usually sufficient to soften the adhesive and to cause the cover glass to stick firmly all around.

A considerable amount of difficulty was found at first in obtaining a method of mounting suitable for use under inconvenient conditions, such as would be met with outside the laboratory.

Method of Counting Dust Particles.—The form of record obtained is a linear deposit of dust of uniform width across the cover glass; this lends itself to a simple method of counting, as a micrometer eyepiece which is ruled in squares of about ½ to 1 mm. may be used, and the number of particles in a strip, the width of one of these squares and extending completely across the record, can be easily ascertained. The number of such strips contained in the record may be found once for all by calculation or by direct counting under the microscope. Knowing the volume of air drawn through the cell, a factor can then be worked out for each jet which, when multiplied into the count of one strip across the record, will give the number of particles per cubic centimeter of air. The counting is done under a 1/12 inch oil immersion objective. In the case of a jet which has been in use for some time, the factor is 13.3, assuming that 50 c.c. of air are drawn through. Thus, if $N =$ the number of particles in one strip transversely across the record, $13.3\ N$ will be the number per cubic centimeter. Although the condensed water is an important factor in causing the dust to adhere to the cover glass, this water evaporates as soon as the cover glass is removed as it is excessively small in quantity; therefore the record itself, after removal, contains no water drops. Thus, the error arising from the fact that drops condense around particles other than dust, such as ions, does not exist. Again, the method does not depend in any sense upon the color of the particles; hence it is applicable to dust of all kinds.

Results

In addition to counting the number of particles per cubic centimeter of air, the size of the particles and their shape can be easily ascertained by direct observation under the microscope; some information as to their nature may also be obtained by examination in polarized light, and by other methods to be described later.

Dust Counts.—As illustrating some of the results obtained from records by this instrument, a few typical dust counts are given below. During the dense fog in London on Sunday, January 22, 1922, a record of 50 c.c. taken gave 21,760 particles per cubic centimeter. The diameter of a large proportion of these particles was 1.7 microns, while the average diameter was about 0.85 micron. The number of large sized particles found during this fog was quite unusual, as such particles are usually very few. During the fog on October 26, 1921, the number of particles obtained per cubic centimeter was 20,800; the average size of the particles was 0.85 micron, and the maximum 1.7 microns. There was a considerable number of spherical particles up to 0.85 micron in diameter.

In comparatively pure air the volume drawn through the jet may have to be increased. For example, in samples taken during August, 1921, on the Norfolk coast it was found necessary sometimes to draw 1,000 c.c. in order to obtain

FIG. 5.—Record showing method of counting. The squares on the photograph are from the lines in the eyepiece micrometer. × 250.

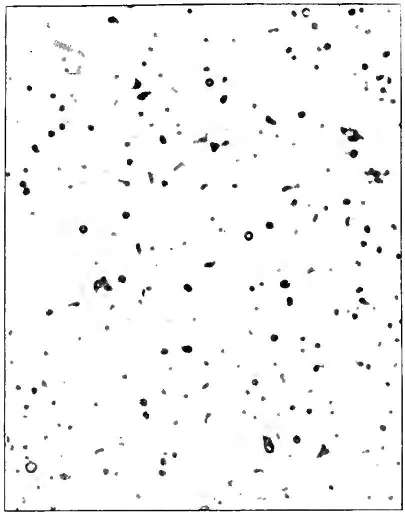

FIG. 6.—London smoke fog. × 2,000.

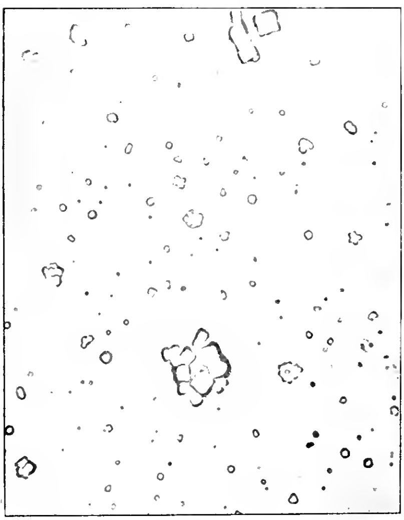

FIG. 7. Record obtained in Villa Real de Santa Antonio, in southern part of Portugal. Practically all the particles are crystals of common salt. × 1,000.

FIG. 8.—Record taken by means of filter pump at Cheam, in Surrey, 12 miles southwest of London, during northeast wind. Note crystals. × 1,000.

a suitable record; and during a slight haze in dry, sunny weather, about 100 to 200 particles per cubic centimeter were found, the size ranging from about 0.3 to 1.7 microns. These were found during a northeast wind and must have been carried across the North Sea from the Continent of Europe (3). A record taken at Cheam, in Surrey, on December 29, 1921, during a northwest by north wind gave 315 particles per cubic centimeter.

Dust in Expired Air.—One important application of the method has been to the discovery of dust in expired air. Since the experiments made by Tyndall (4), in which he examined expired air by means of a powerful beam of light from an arc lamp brought to a focus in the air by means of a lens, it has been very commonly assumed that expired air was dust free, although Tyndall stated that it was only air from the depths of the lungs that he found dust free. This matter was examined again by means of the jet apparatus. Air expired during ordinary breathing was found to contain about 70 per cent. of the dust particles which were breathed in; while the air from the depths of the lungs, after quiet breathing, contained from 2.5 to 7 per cent., and after deep breathing over 20 per cent. Inspiration was, in all cases, through the nose. This is a somewhat important result, since it throws some light upon the causation of dust diseases, such as silicosis. The author read a paper on this subject before the Medical Society of London on December 12, 1921, and the summary of conclusions arrived at from these experiments was given as follows:

1. The air passages do not act efficiently as a filter, except for the removal of very large dust particles.
2. When breathing dust laden air, it is only after a long period of quiet breathing that the air from the deep parts of the lungs approaches being dust free.
3. When the air from the depths of the lungs is dust free, it is not due to the removal of dust from the air in its passage to the alveoli but to deposit of the contained dust in or near the alveoli.
4. Normal quiet breathing may not carry any dust into the deeper parts of the lungs, and such dust as is carried into the air passages can be dealt with and removed by ciliary action.
5. Deep breathing following exertion or coughing, or accompanying sneezing or yawning, or by voluntary action, draws the dust into the deeper parts of the lungs, beyond the ciliated lining of the air passages, and thus beyond the mechanism provided for its removal.
6. It is suggested that during work in dust laden air it is the deep inspirations, resulting from the above causes, which are responsible for bringing about disease.
7. Nose breathing does not protect against dust.
8. It is doubtful how far exercises involving deep breathing should be recommended to city dwellers under present conditions, owing to the polluted state of the air.

Microchemical Examination

The fact that the efficiency of the jet depends upon condensation of moisture has made possible other methods of examination of the suspended matter of the air. Referring to the illustration of the apparatus, it will be noticed that the damping chamber is of tubular form and when the instrument is in use it usually hangs downwards, or may be pointed in any desired direction, the apparatus being held by the pump. It was found that if the apparatus was held by the damping chamber, a curious result was brought about: The heat of the hand caused moisture to evaporate from the damp lining of the chamber in greater quantity than the air could take up, and thus a fog could be detected inside the chamber. A record taken under such conditions was so affected by impact of the water drops that it was uncountable.

The water flowed out sideways from the linear record, leaving the stream beds free from particles, which were stranded round the margin of each little stream.

This fact was pressed into service in the following way: It was found that when a large volume of air was drawn through the jet so that a perfectly opaque record was obtained, and during the process the damping chamber was slightly warmed, the condensed water striking the record flowed out sideways, as previously described, dissolving in its passage some of the soluble matter contained in the record, which subsequently crystallized out on the dried up stream beds, when the water evaporated. These crystals could then be examined microscopically and microchemically, and the nature of the salts forming them ascertained.

In order to simplify the recognition of such crystals, a set of standard slides was prepared. These slides had cover glasses on which crystals of the sorts most likely to occur in atmospheric dust were formed artificially. The following is a list of the standard crystals so prepared:

Ammonium chloride.
Potassium chloride.
Sodium chloride.
Ammonium sulphate.
Potassium sulphate.
Magnesium sulphate.
Sodium sulphate.
Potash alum.
Sodium thiosulphate.
Sodium nitrate.
Magnesium carbonate.
Ammonium acetate.
Sodium sulphite.
Ammonium nitrate.

In addition to these, slides of pure silica and alumina powders were prepared. By examining the crystals, comparing them with the standard slides, and measuring the interfacial angles and behavior under polarized light, it is probable that most of the salts in atmospheric dust can be recognized.

This phase of the investigation has been undertaken only recently, and has not been carried very far up to the present time.

Acidity and Alkalinity.—Owing to the effect of the condensed water referred to in the foregoing, it was thought that if a chemical indicator were used on the cover glass upon which the record was taken some information should be obtainable as to the acidity or alkalinity of the air. Cover glasses coated with a solution of gelatine in water, to which different indicators were added, were prepared and experimented with. The indicators tried were methyl orange, congo red, phenolphthalein, erythrosin (iodeosin). With regard to the methyl orange used in this way, it was found that since the color change was from red to yellow, or *vice versa*—that is, the film was initially colored either red or yellow—a change of color on the surface of the film, if sufficiently shallow, was not detectable. The same objection applied to congo red; whereas with phenolphthalein, in which the color change was from colorless with acid to pink with alkaline, the depth of color obtainable with a thin film was not sufficient to be recognized under the microscope. A further objection was the absence of a characteristic color for acid. Erythrosin was too difficult to apply as it required the presence of ether.

Following the gelatine experiment trials were made with filter paper colored with methyl orange or congo red. The method was to prepare some paper which had the characteristic color for acid or alkali but was as nearly neutral as it was possible to get, consistent with distinct coloration. Two half disks of each paper were then cut and fixed on

a metal ring of the same diameter as the cover glass used in the jet apparatus. This ring was placed in the apparatus instead of the cover glass and in such a way that the linear record would be taken half on one paper and half on the other. This method gave somewhat promising results; a definite alkaline reaction was detected in one case. Only a few experiments on these lines have yet been carried out, and further experiments will be made using the most neutral filter paper obtainable.

A third method used was to crystallize on to the cover glass a little indicator from solution, and to take the record on a cover glass so prepared, care being taken to have the damping chamber warm while the record was being obtained. Experiments made on these lines point to this method as probably being the most sensitive, since definite indications of both acidity and alkalinity were obtained. During the dense fog on Sunday, January 22, 1922, the reaction of the dust collected was decidedly acid both to congo red and to methyl orange. On the Friday previous to this a definitely alkaline reaction was obtained. The acidity referred to does not necessarily imply the presence of free acid as both methyl orange and congo red are sensitive to salts, the latter particularly so to calcium salts.

Tests by Volatilization.—Another method of examination applied to records obtained in London was as follows: A very dense record having been made upon the cover glass by drawing through a large volume of air, approximately 1,000 c.c., the cover glass was removed and a shallow metal ring, about $\frac{1}{2}$ mm. deep, was placed on top of the glass and the ring covered by a second cover glass. The lower glass was then heated gently over a gas flame, a drop of water being placed upon the exposed surface of the upper cover glass to keep it cool. After cooling, the upper glass was removed and on its surface was found a deposit of something which had been driven off from the record and condensed. On examination under the microscope this deposit was found to consist of small rounded drops of dark, oily liquid soluble in oil. This liquid was doubtless tar.

No crystals were observed but it is probable that by improved methods it will be found possible to obtain crystals volatilized from the record in this way.

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2. Aitken, J.: On the Number of Dust Particles in the Atmosphere. Tr. Roy. Soc. Edin., 1887-1890, *35*, 1. See also: Proc. Roy. Soc. Edin., 1890-1891, *18*.
3. Owens, J. S.: Suspended Impurity in the Air. Proc. Roy. Soc., Ser. A, 1922, *101*.
4. Tyndall, J.: Essays on Floating Matter of the Air. London, 1883, p. 46.

BOOK REVIEW

Merchant Seamen: Their Diseases and Welfare Needs. By *W. E. Home.* Pp. 111. London: John Murray, 1922.

The picture drawn in this book of life at sea as lived by British seamen is the reverse of attractive. Dr. Home tells the history of the past, not in order to extenuate but to explain the present; thus, to take one instance, the Merchant Shipping Act, 1906, ordered ship owners to pay over to the Board of Trade wages due to deserters. Why? Because previously (and the custom is still surreptitiously honored) captains were expected to make life on board so unpleasant that crews deserted; then, of course, no wages were paid—an economical proposition for the owners. A new crew was then engaged, and the process was repeated. One captain boasted that his owners had not had to pay wages for five years; another who returned with his original crew was promptly dismissed! Traditions last long; and the spirit and conditions needed to incite desertion are not quickly altered.

Rear-Admiral Boyle Somerville told in Blackwood's Magazine in 1920 of the conditions which he found when he took over a great liner as an armed merchant cruiser. No proper accommodations for civilized seamen and firemen had been provided. The narrow depths of the forecastle sufficed; no place, this, at any time, for men. The firemen were in the deeper depths beneath. "Round the filthy sides of each den there were riveted as many iron bed-frames, one above the other, as spaces could be found for them, to the number of about fourteen. Each bed contained its proper human occupant, dirty and sweaty, just as he had come from the stokehold. . . . Each man, as he came off watch, whatever the day or hour, threw himself down on the bunk, just as he was, and there remained until it was time for him to go to his next turn of watch in the stokehold. . . . As for meals, when the time for them came round, the members of each den took it in rotation to go up to the cook's galley and bring down thence, in a large tin dish, the mess of meat and gravy, or whatever was provided. On its arrival, each man reached forth from his bed, took with his hand, out of the dish as it went by, his gruesome portion, and, lying there, devoured it. . . . There were no plates, knives or forks, no table on which to lay them, nor even a bench on which to sit down to eat."

COMPARATIVE MORTALITY FROM CERTAIN CAUSES AT AGES 25-65[1]

Occupation	Phthisis		Pneumonia		Accidents		All Causes	
	1900-02	1910-12	1900-02	1910-12	1900-02	1910-12	1900-02	1910-12
Seaman Merchant Service	262	260	125	126	257	199	1646	1485
Clergyman Priest Minister	55	45	34	28	9	13	524	443
Coal miner	89	76	86	64	123	118	885	727

[1]These figures do not appear in the book.

Dr. Home gives several descriptions of accommodation for seamen in ships of today, British and United States liners, and freight boats; great variety exists, but even the best hardly attain a reasonable standard of hygiene. The provisions of the Bill presented to the House of Commons in 1921 give some indications of this standard; in order to improve it the proposal is made that each seaman should have 140 cubic feet of space, but space for mess-rooms, bathrooms, and washing places, if provided, may be included in the 140 cubic feet! A death rate of 7.8 per thousand for the merchant service is compared with 3.3 for the navy and 3.0 for the army; even after the greater age of the seamen is allowed for, a serious surplus remains. Apart from accidents—for which cause of mortality the seaman is far ahead of all occupations—respiratory diseases, especially

pneumonia and tuberculosis, are unusually prevalent (see table); the latter disease is especially rife among Lascar seamen.

Attention is directed to what is being done for factory operatives and coal miners; and a plea is entered that seamen need welfare accommodation and welfare supervisors, a welfare fund such as that of the miners, and compensation for tuberculosis contracted at sea. They need good ventilation, and warm and dry quarters. Above all they need reasonable treatment and opportunities for healthy recreation at sea and in port. and last, but not least, continuous service.—*E. L. Collis.*

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers and as space permits.

Mental Causes of Accidents. By *Boyd Fisher.* Cloth. Pp. 315 with preface. Boston and New York: Houghton Mifflin Company, 1922.

Labor Problems and Labor Legislation. Second Edition Completely Revised. By *John B. Andrews,* Ph. D., Secretary, American Association for Labor Legislation; Joint Author, History of Labor in the United States; Member, President's Conference on Unemployment; Editor, American Labor Legislation Review. Cloth. Pp. 135 with table of contents. New York City: American Association for Labor Legislation, 1922.

Feeding, Diet and the General Care of Children: A Book for Mothers and Trained Nurses. By *Albert J. Bell,* A.B., M.D., Assistant Professor of Pediatrics in the Medical Department of the University of Cincinnati; Attending Pediatrician to the Cincinnati General Hospital, The Tuberculosis Hospital and the Christ Hospital; Member of the Medical Milk Commission, and Chairman of the Divisional Council on Child Hygiene, Cincinnati, etc. Cloth. Pp. 276 with table of contents, index and illustrations. Philadelphia: F. A. Davis Company, 1923.

Physical Exercises for Invalids and Convalescents. By *Edward H. Ochsner,* B.S., M.D., F.A.C.S., President, Illinois State Charities Commission; Attending Surgeon, Augustana Hospital, Chicago. Cloth. Second Edition. Pp. 56 with preface and illustrations. St. Louis: C. V. Mosby Company, 1922.

SUBJECT INDEX TO VOLUME IV

This is a subject index to all the reading matter in the JOURNAL OF INDUSTRIAL HYGIENE, and one should, therefore, look for the subject word, with the following exception: "Book Notices" are indexed under this title on page 539. The name of the author follows the subject entry in parentheses.

For author index, see page 540.

BOOK NOTICES

AUTHOR INDEX TO VOLUME IV

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

SUPPLEMENTARY TO

THE JOURNAL OF INDUSTRIAL HYGIENE

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CONTENTS

GENERAL

THE WORK OF THE INDUSTRIAL FATIGUE RESEARCH BOARD AND ITS APPLICATIONS TO INDUSTRY. *D. R. Wilson.* Jour. Roy. Soc. Arts, Nov. 18, 1921, 70, No. 3600, 3-20.—This paper presents a bird's eye view of the investigations which have been made in England by the government for the purpose of studying the human factor in industry. Mr. Wilson points out how precautions to protect the health and safety of workers have now been extended through attention to their physiological and psychological response to industrial environment. The methods followed have been the measurement of output, of morbidity and mortality, of labor turnover, of lost time, and of accident incidence. Output has proved the most valuable measurement so far, but the others have been closely studied. Results have been obtained which throw light upon optimum hours of work, upon impersonal factors in efficiency, such as temperature, ventilation and lighting, and upon personal factors, such as vocational selection and motion study. Excellent diagrams are reproduced showing hourly rates of charging blast furnaces, of output in silk weaving, and of innate diurnal rhythm; other diagrams exhibit variations in output throughout the week in different industries. The effect of seasonal changes, of lighting and of practice are also shown. Variations in output due to these different influences are shown to be far more than sufficient to make an industry prosperous or the reverse. The Board is now appealing to industries in their own interests to come forward and help in this work, the value of which has been so incontestably proved.

Mr. Wilson claims that the work of the Board is the first systematic attempt to ascertain facts; that it has a direct and important bearing on the increase of production; that it has laid bare facts deserving of immediate attention; and that already the results are bearing fruits. Those unacquainted with the work of the Board will find this article of great value.—E. L. Collis.

Vocational Guidance (A Review of the Literature). *B. Muscio.* Indust. Fatigue Research Board, Report No. 12. His Majesty's Stationery Office, London, 1921, pp. 57.—Among the factors affecting human efficiency in industry, perhaps one of the most important is some method of ensuring that, so far as practicable, every worker shall be placed *ab initio* in an occupation for which he is naturally fitted. The high labor turnover commonly occurring among beginners employed in factories tends to show that the initial selection of an occupation is often a matter of chance, and that any permanent employment subsequently obtained is only secured after a process of trial and error. Apart from other considerations, there can be nothing more discouraging than the realization that a long period of training has only been partly effective and that the time so spent might have been used more profitably in another sphere.

The recognition of these facts has led to the development in recent years of the methods known as vocational guidance. Vocational guidance may be defined as a policy that attempts, on a scientific basis, to guide each individual into an occupation for which his psychophysiological constitution fits him, and is to be distinguished from vocational selection. The former results from asking: For what occupation is this or that individual best fitted? The latter results from asking: Is this or that individual fitted for this particular occupation? The former question places at least as much emphasis on the needs of the individual as on the needs of industry; the latter emphasizes the need of a particular industry.

It has been urged in favor of vocational guidance that adaptation of the worker to his work on the basis of natural fitness may be expected *(a)* to effect a decrease of industrial fatigue; *(b)* to bring about an increase in output; *(c)* to produce a situation in which the worker finds more interest in his work; *(d)* to reduce labor turnover; and *(e)* to reduce the number of industrial accidents, partly by lessening labor turnover, and partly by guiding those who are naturally likely to have accidents into occupations in which accidents are impossible.

Methods in Vocational Investigations.—The currently accepted method for determining the psychophysiological capacities required in a given occupation is as follows: Groups of persons engaged in the occupation and representing different grades of efficiency are given a number of tests, the results of which are compared with work records by the method of correlation. Probably the chief difficulty to be overcome in carrying out this procedure is that of obtaining a reliable efficiency grading for the occupation.

The choice of the tests to be used in any given case has been guided by a variety of considerations. The different procedures by which the desired information may be obtained have been classified as follows: *(a)* The experimenter may use sample tests: that is, standardized samples of the actual work may be used as tests. *(b)* He may use analogous tests: here the test is no part of the actual work but is modelled on it and is similar to it. *(c)* He may first observe the occupation and analyze it into its psychophysiological or neuromuscular elements, and then give standard tests for each of these elements. *(d)* Or, finally, a very empirical method may be used: the experimenter may give a number of tests chosen at random and simply accept as good tests those which yield large correlation coefficients with efficiency in the occupation. In practice, this fourth procedure is usually more or less similar to the third, since practical reasons always demand some limitation of the number of tests used.

It has sometimes been urged that vocational aptitudes are determined not so much by the possession or lack of special mental or physiological capacity as by general emotional and temperamental qualities. A few attempts have been made to determine whether *interests* could be made the basis of vocational guidance. The results obtained by different investigators, however, are very conflicting. There is the difficulty of estimating the intensity of an interest, the psychological facts of competing

interests, the relatively fleeting character of many interests, and the fact that many occupations excite little or no interest. When it is added that the relation of interest to capacity is ambiguous, and that a youth's interests are often a consequence of insufficient knowledge about occupations, it seems clear that little use can be made of interest by vocational guidance. It is generally recognized, however, that temperamental factors are very important, and their relation to different occupations is urgently in need of investigation.

Special Investigations.—Detailed accounts are given of all the past investigations that have been carried out on vocational guidance. The occupations studied include clerical work, engineering and metallurgical work, music, printing, salesmanship, telegraphy, telephone operation, transport work, and a few miscellaneous occupations.

Future Investigations.—While the investigations reviewed suggest that a scientific vocational guidance policy is certainly possible, it is difficult to assess the value of many of the results. The investigations not infrequently give the impression of somewhat rough and ready attempts to solve practical problems; and there is sometimes about them an air of accidentalism both as regards the person upon whom tests were made and also as regards the tests that have been used. Different investigators, attempting to discover the capacities required for the same occupation, have sometimes obtained significant positive correlation coefficients with very different tests. In such instances, the conclusions of the investigators are probably individually one-sided and need to be combined.

What seems necessary now is a far more systematic and sustained investigation into the capacities required for different occupations than has hitherto been attempted. If a sound basis is to be obtained for vocational guidance, occasional investigations of the type reviewed, the possibility of which depends upon the willingness of a few employers and groups of workers to co-operate with the scientific investigator, while suggestive and useful up to a certain point, are insufficient.

A more adequate method of investigation suggests itself. Large numbers of young persons who are about to enter industry might receive a thorough psychophysiological examination. As far as possible, they should be re-examined annually for several years, first to guard against errors, always possible in a single examination, and, secondly, to determine what changes, if any, are produced in the ability to carry out different tests by working at different occupations. During a period of from seven to ten years, an exact record should be kept of the industrial history of those who are examined, and their success or failure in different occupations should be correlated with their psychophysiological constitution. Within a decade an investigation of this nature, if carried out systematically and extensively, should lay a satisfactory scientific foundation for a national vocational guidance policy.

The points to be emphasized concern: (1) the exact nature of the problems to be investigated; and (2) the method of investigation.

In view of the investigations above reviewed, the *problems* may be stated as follows: *(a)* to determine the *general intelligence* level required by each occupation; *(b)* to determine the *special* capacities (including physiological characteristics) required by each occupation; *(c)* to determine the relation of *temperamental* qualities to efficiency in different occupations.

Concerning general *methods*, it is suggested: *(d)* that investigations similar in type to those reviewed should be carried out in as large a variety of occupations as possible; *(e)* that, in addition, extensive investigations, to be continued over a number of years, should be inaugurated, for the purpose of making psychophysiological measurements of young persons in different occupations and of comparing such measurements with occupational records.

The report concludes with a valuable bibliography of English and foreign literature dealing with the subject.—D. R. Wilson.

Report of the Division of Industrial Safety. Reprinted from Ann. Rep. Mass. State Dept. Labor and Industries, Boston, 1921, pp. 83.—The work of the former Board of Labor and Industries is continued in the Division of Industrial Safety of the new Department of Labor created under chapter 350 of the General Acts of 1919. The duties of the Division include the administration of the laws regarding the employment of women and minors; regulating

labor on public works; providing for the adequate lighting, ventilating and sanitation of industrial establishments; providing for the guarding of dangerous machinery; regulating tenement-house work; and the administration of such general labor laws as those regarding one day's rest in seven, the weekly payment of wages and advertising for employees during strikes.

The report gives in detail an account of the work of inspection, the number of visits, and the testing of the "block system;" and there are sections on hours of employment for women and minors, industrial safety, building trades, new rules for woodworking machinery, safeguarding of machinery by manufacturers, hoods for grinding wheels, industrial health, occupational diseases (lead poisoning, anthrax, dermatitis, poisoning by gas and fumes), courses in industrial hygiene at Harvard Medical School, special investigations, health hazards in the granite-cutting industry, health of women and minors in laundries, accident prevention, the transportation industry, licenses for home work, hours for public employees, and weekly payment of wages. An appendix of about forty-five pages contains a tabulated report of home permits, employment certificates and educational certificates issued during 1920.

Many facts of general interest from the point of view of industrial hygiene may be gleaned from the report:

During the year about 4,000 orders dealing with hazards found in the various industries were issued. The "significance of these figures is more fully realized when it is understood that in a large manufacturing establishment the issuance of a single order frequently results in removing many hazards."

There were more than 3,000 tabulatable accidents in the building trades of the state in the year ending June 30, 1919, and now four inspectors are giving their time to securing compliance with rules and regulations for the prevention of accidents in building operations. The regulations require firms engaged in painting to register with the Department, and much has been done to prevent the use of bad stagings.

Accidents of the most serious kind occur in the use of grinding wheels covered with cast-iron hoods. A cast-iron hood will not hold parts of broken wheels. Steel hoods prevent accidents. A grinding wheel safety code is now in process of preparation, and some tentative rules are reported. It is advised that hoods be mounted so as to maintain alignment with wheels, the fastenings to have ample strength to minimize displacement in case of wheel breakage.

It is said that despite work done in regard to first-aid equipment, infection from minor injuries seems to be on the increase, and the statistics show that during the year there were 5,603 cases of infection, eighteen fatal, and twenty-seven causing permanent partial disability. The principle of first-aid treatment is not successful without the real co-operation of the employees.

During the year, eighteen cases of anthrax have been reported and have been investigated. Usually in plants where there is danger of infection, good first-aid rooms are provided and foremen are instructed to report all cases of cuts, bruises or abrasions of the skin and to require employees to report for medical treatment.

Fifty cases of lead poisoning have been investigated. Attention is called to the hazard of scouring automobile bodies with sandpaper after the priming coat has been applied, and to the possibility of absorption of lead through the skin in some kinds of work.

"New conditions in the industrial world have contributed to make fume and gas poisoning a serious problem in connection with the general health of employees in certain types of establishments." The manufacture of dyes, coal tar products and benzene is often carried on without much protection. Suitable exhausts, and provision of sanitary and washing facilities are necessary.

Special investigation was made of the effect of different processes in the manufacture of tobacco upon the health of employees. The effect upon beginners and upon minors, the danger of tuberculosis and other respiratory diseases, occupational neuroses, dermatitis, toxic amblyopia, and the general effect on the health of women, especially with regard to the genital system, were considered.

The health hazards in the granite-cutting industry were also given especial attention. The introduction of compressed-air surfacing machinery with the use of pneumatic tools has increased the hazards in this industry by generating a powdery dust which is easily inhaled. In the finer work the face is brought close to the point of operation, thus increasing the risk. Portable exhaust systems can be made to remove the dust.

The wet wash laundry, the latest development in this industry, is usually carried on under bad conditions, with crowding of machinery and inadequate provision for the disposing of waste water and steam.

More fatal accidents take place among employees in the transportation industry than in any other. Of a total of 376 fatal accidents in the state during the year, 102 were in this industry.—G. E. Partridge.

SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Experimental Tar Cancer. *B. Bloch* and *W. Dreifuss.* Abstracted as follows from Schweiz. med. Wehnschr., Nov. 10, 1921, 51, No. 45, 1033, in Jour. Am. Med. Assn., Jan. 14, 1922, 78, No. 2, 152.—"Bloch and Dreifuss were conducting research in this line in 1912, and resumed it in 1920. They experimented with rabbits, guinea-pigs and white mice. Their results with rabbits were like those published by the Japanese investigators in this line, but the cancers induced in white mice surpassed them in every respect. Guinea-pigs have proved refractory to date. The special feature of their research is that they experimented with the different elements of the coal tar, as well as the whole tar, painting the back of the white mouse with the substance daily for 160 days or more. The tumors continue to grow in diameter and depth after the applications have been suspended, and metastatic tumors were found in axillary and inguinal glands and in the lungs. They found up to 20 metastatic nodules in one lung, and this lung metastasis was evident in 30 to 40 per cent. of the mice that lived long enough. Their experiments with the different elements of the tar demonstrated, they say, that the cancer-inducing fraction is a substance with a boiling point of over 300° C. freed from the bases, phenols, etc., that boil at a low temperature. It is effectual even after distillation, inducing in four months in 100 per cent. extensive and rapidlygrowing malignant tumors. The work was done at the dermatologic clinic at Zurich of which Bloch is chief."—C. K. Drinker.

CENTRAL NERVOUS SYSTEM

The Neuroses and the Industrial Commission. *Lewis J. Pollock.* Nation's Health, Jan. 15, 1922, 4, No. 1, 40-42.—In this paper the author discusses at some length the traumatic hysteria which frequently results from an industrial accident. Hysteria following injury may be due to several causes: "(1) fear of being severely injured, unable to resume occupation and support of family with ensuing desire for pension; (2) resentment and desire for compensation, and rarely for causes not associated with either of these two, such as would have produced hysteria had any other 'accident' than injury occurred.

"Is it meant by this that these patients are faking, putting this on, that they hypothecate their illness? It is not. They suffer just as much as if they were disabled from organic causes. Is the condition imagined? It is not. . . . The symptoms are real enough, but they occur only because of suggestion, not because of injury or shock. Usually the patient is injured or is in an accident, he experiences some pain or slight disability, he is fearful lest it be serious, he becomes introspective, attentive to himself, sensations which formerly he would dismiss are now indicative of serious ailment. His friends ask him innumerable questions with entailing suggestions. An enforced period of idleness occurs. He is examined by physicians, who, by injudicious questions, suggest new symptoms. He is fearful lest he be unable to resume his occupation and support his family. Here in short is a well prepared

field for the development of severe signs of hysteria. He seeks compensation and legal advice and forthwith a hysteria develops. It does not occur immediately after accident, it occurs following a latent period during which time suggestion has had an opportunity to act."

Such a man is not a malingerer. Malingering is a "wilful imitation of disease for the purpose of gain. . . . Although back of both conditions there is an illicit motive, the hysterical patient is not aware of it."

What relation does compensation bear to hysteria? "It is the opinion of contemporary neurologists that were it not for possibility of compensation the traumatic neuroses would practically not exist.

"Litigation holds out promise of reward and fosters the neuroses. Prolonged litigation prolongs the duration of a neurosis and prolonged forms of compensation work to the same end. . . . As soon as it is recognized that immediate final settlement cures a hysteria, it will be found that the amount of expense, otherwise prolonged, will be reduced. The quicker the patient recovers, whatever the initial cost, the less, in my opinion, will be the expense. Certainly an early and final settlement is the only just procedure for such a case. In addition to this several essential features in the handling of such a case stand out; an early and correct diagnosis by competent observers, avoidance of careless examinations and ignorant diagnoses, a quick return to some form of work, and avoidance of prolonged litigation and its ensuing chances for suggestions and fixation, particularly when the patient is an observer of the trial of his case."—Katherine R. Drinker.

MENTAL

Hygiene of the Mind. *L. Bianchi.* Abstracted as follows from Riforma Med., Dec. 3, 1921, 37, No. 49, 1141, in Jour. Am. Med. Assn., Feb. 11, 1922, 78, No. 6, 474.—"In this opening lecture of the course on nervous and mental diseases, Bianchi emphasized among other things the stabilizing effect of work on the mind, and deplored the prevailing conception that the fewer hours we have to work the better off we are. 'This is the view which politicians and labor leaders—to promote their own selfish interests—are impressing on the public. The result is that the shortening of the hours of labor, instead of giving leisure for home duties and family life, is deteriorating character and mental health as the free hours are devoted to loafing. Work—the great stabilizer of the nervous system—is abhorred and shirked more and more—a sad perversion of the ideal aimed at in the early agitation for the eight hour day.' Nervous disease is becoming more and more prevalent, and the number of the insane has trebled in the last twenty years. Physicians should be on the lookout for anomalies in character as well as in the blood or tissues. He says that his forty years of practice have demonstrated that anomalies in character in children can be effectually combated by wise management and hygiene, either in the home or with some wise and patient teacher. Those children that failed to get this favorable environment or were sent to a large school where all were treated alike, had their abnormal traits intensified, and grew up to be candidates for the reform school or asylum."—C. K. Drinker.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Gas Masks for Gases Met in Fighting Fires. *A. C. Fieldner, S. H. Katz,* and *S. P. Kinney.* U. S. Bur. Mines, Tech. Paper 248, Aug., 1921, pp. 61.—This report, which is well supported by a bibliography and a very complete index, sets forth in simple technical and non-technical language the advantages and disadvantages, under very definite conditions, of a modified type of United States Army gas mask for use in fighting fires of various origins.

It is pointed out that of the combustion products of explosives and fuels, both liquid and solid, carbon monoxide is the most dangerous and is not absorbed by the present type of army gas mask. A new mask and absorbent now being devised will, it is believed, be effective against this gas, as well as against

the other gases usually encountered in fighting fires. From a physiological standpoint carbon monoxide and the oxides of nitrogen are the most dangerous and consequently the most important gases to the fire fighter. The safest means at present of obviating the effects of these two gases is by the use of oxygen or air breathing apparatus, although this is cumbersome and not popular with firemen.

The present army gas mask effectively absorbs the following products resulting from the heating of carbon tetrachloride when used as a fire extinguisher: chlorine, sulphur dioxide, vapors of ammonia, acetone, alcohols, aniline, chloroform, ether, toluene, benzene, carbon disulphide, carbon tetrachloride, formaldehyde, turpentine, phosgene and hydrochloric acid gas. Carbon monoxide, illuminating gas as containing physiologically dangerous percentages of carbon monoxide, nitrogen oxides, gasoline and petroleum vapors are best obviated by the use of oxygen respirators, or gas masks to which a source of pure air is connected by non-collapsible rubber tubing.

Several types of gas masks and of air and oxygen breathing apparatus are described and illustrated. The preparation of absorbents for cannisters is dealt with and their respective limitations pointed out. Highly activated charcoal, soda lime, silica-gel as an ammonia absorbent, as well as salt hydrates of copper, cobalt and nickel with silica-gel, are described in detail.

Experiments with incompletely burned fires in closed spaces are tabulated, with analyses of the gases resulting. Specifications for fire fighters' masks are appended, with a table of thirty-six gases most commonly encountered in fire fighting, and a list of Bureau of Mines publications relating to this general subject.—Philip Drinker.

The Catalytic Oxidation of Carbon Monoxide. *T. H. Rogers, C. S. Piggot, W. H. Bahlke*, and *J. M. Jennings*. Jour. Am. Chem. Soc., Sept., 1921, 43, No. 9, 1973-1982.—This research was undertaken for the Chemical Warfare Service for the purpose of providing a gas mask ingredient which would be a suitable oxidizing agent against carbon monoxide. The most satisfactory mixture was found to be manganese dioxide with silver or copper oxide, or both. Water vapor was found to exert an appreciable effect on the life of the catalysts.

Persons interested in the subject of industrial respirators are referred to the reviews of articles by Levy and West, and Desgrez, Guillemard, Hemmerdinger and Labat, which appeared on pages 247 and 248 of the abstract section of the March issue of This Journal.—Philip Drinker.

The Catalytic Oxidation of Carbon Monoxide at Ordinary Temperatures. *D. J. Merrill* and *C. S. Scalione*. Jour. Am. Chem. Soc., Sept., 1921, 43, No. 9, 1982-2002.—This is a report of a Chemical Warfare Service investigation on the development of a suitable catalytic mixture for use as an oxidizing agent for carbon monoxide. The authors found the two most satisfactory mixtures to be manganese dioxide and basic copper carbonate, and manganese dioxide, copper oxide, cobaltic oxide, and silver oxide, respectively. The use of a drying agent, such as calcium chloride, is pointed out, and the various factors influencing the activity of the catalysts are discussed.—Philip Drinker.

Carbon Monoxid Poisoning. *H. Günther*. Abstracted as follows from Ztschr. f. klin. Med., Nov. 15, 1921, 92, No. 1-3, 41, in Jour. Am. Med. Assn., Feb. 4, 1922, 78, No. 5, 396. —"Günther found evidence of polyneuritis from illuminating gas poisoning in about 1 per cent. of the 215 cases at the Leipzig medical clinic in the last thirty years. Hemorrhagic polymyositis was noted in three cases, accompanied by elimination of a peculiar pigment in the urine in the one fatal case." —C. K. Drinker.

Methane in California Gold Mines. *B. O. Pickard* and *E. D. Gardner*. U. S. Bur. Mines, Reports of Investigations, Serial No. 2303, Dec., 1921.—The authors describe the occurrence of methane in certain California gold mines, the geology of its formation, and its detection and properties. They refer to eleven Bureau of Mines' circulars relating to this gas.—Philip Drinker.

The Determination of Oxides of Nitrogen. *V. C. Allison, W.L. Parker*, and *G. W. Jones*. U. S. Bur. Mines, Tech. Paper 249, Sept., 1921, pp. 13.—This pamphlet discusses the physiological effects of oxides of nitrogen, the sampling of gases containing these oxides,

and their quantitative determination by the di-phenyl sulphonic acid method. It is pointed out that there is no advantage in determining nitric and nitrous oxides separately, since the former is ultimately oxidized to nitrogen peroxide in the presence of oxygen and then forms nitrous and nitric acids in the presence of water vapor. The authors claim that 10 parts of oxides of nitrogen as nitrate could be detected in 1,000,000 parts of the air oxides of nitrogen mixture, with an accuracy of 5 or 6 parts per million.—Philip Drinker.

Blood in Tetrachlorethane Poisoning. *G. R. Minot* and *L. W. Smith.* Abstracted as follows from Arch. Int. Med., Dec., 1921, 28, No. 6, 687, in Jour. Am. Med. Assn., Jan. 14, 1922, 78, No. 2, 146.—"A study by Minot and Smith of the blood of sixty-eight persons exposed to a greater or lesser degree to tetrachlorethane, indicates that blood examination is of value in the prevention of tetrachlorethane poisoning and in the diagnosis and prognosis of poisoning by this substance. The blood changes usually can be observed before clinical symptoms develop. The blood abnormalities include *(a)* a progressive increase of large mononuclear cells, often reaching 40 per cent. This is the most important change. *(b)* The appearance of many immature large mononuclears. *(c)* A slight elevation in the white count. *(d)* A progressive but slight anemia. *(e)* A slight increase in the number of platelets. A percentage of large mononuclear white cells above 12 is the first sign of a reaction to tetrachlorethane, and is a signal for close observation of that person. The presence of a considerable number of young large mononuclear cells, some formed and many broken, is to be considered as indicating a severer condition than when the same number of more mature large mononuclears are present."—C. K. Drinker.

Experimental Poisoning with Picric Acid. *Candela* and *Amelio.* Il Lavoro, Nov. 30, 1921, 12, No. 7, 213-214.—In certain animals, for example guinea-pigs, it is impossible to produce icterus by administering picric acid, although there is a marked toxic effect. In others, such as dogs, striking icterus is produced which is hematogenous in nature. Applying these results to picric acid poisoning in man, it can be seen that they throw doubt on the theory that the yellow tint of the skin is to be attributed solely to the affinity of picric acid for the cells of the cutis. Examination of the urine shows only traces of urobilin and biliary pigments as is usually true in hemolytic jaundice in man, which fact seems to point to the conclusion that in man, as in dogs, the jaundice of picric acid poisoning is a hemolytic jaundice. In cases of icterus of this character it is important to remember that the individual may have a predisposition to erythrocytic fragility which is perhaps not as infrequent as has been supposed.—Alice Hamilton.

Treatment of Acute Phosphorus Poisoning. *H. V. Atkinson.* Abstracted as follows from Jour. Lab. and Clin. Med., Dec., 1921, 7, No. 3, 148, in Jour. Am. Med. Assn., Jan. 21, 1922, 78, No. 3, 244.—"Atkinson asserts that liquid petrolatum given one hour after taking phosphorus furnishes complete protection against the onset of harmful symptoms. Liquid petrolatum is physiologically inert and acts entirely by reason of its physical properties. Its use is recommended in the treatment of phosphorus poisoning. Since liquid petrolatum is a harmless and non-irritating cathartic, it may be used to delay absorption from the intestine in many, perhaps all, cases of poisoning."—C. K. Drinker.

DUST HAZARDS AND THEIR EFFECTS

Automatic Filter for the Measurement of Suspended Impurity in the Air. *J. S. Owens.* Jour. Roy. San. Inst., Jan., 1922, 42, No. 4, 265-268.—Dr. Owens describes an automatic filter which he has designed for the measurement of suspended impurity in the air. The apparatus is essentially an automatic aspirator by means of which, at regular intervals of time, which may be varied in length at will, a fixed volume of air is drawn through a filtering paper of sufficiently fine texture to collect on its sur-

face the whole of the dirt in the air in the form of a discolored patch which can be interpreted later. This is combined with a clock-work arrangement for moving the paper after each record is taken, so that a fresh filtering area is brought into position for the next record, and the time of each record is registered. The filter paper, which is in the form of a disk and is separated into twenty-four hourly divisions, rotates with the clock. At regular intervals air is drawn through a patch of the paper. In action the volume of air drawn through the paper at each operation is exactly two liters at atmospheric pressure—a volume which has been found quite convenient. Each record is interpreted by comparing the blackness with a standard scale of shades calibrated by comparison with larger paper filter records, the deposit on which has been actually weighed. The scale of shades consists of squares numbered from 1 to 20, of even gradation of shade from white to nearly black. The matching presents little difficulty and results can be expressed in absolute units, each shade having been found to represent 0.32 mg. of dirt per cubic meter, which is equivalent to 0.54 pounds per million cubic yards. The only attention which the instrument requires is the changing of the paper disk once every twenty-four hours, and the daily winding of the clock.—E. L. Collis.

Pneumonoconiosis and Asthma in Saw Mill Workmen. *K. Gade.* Abstracted as follows from München. med. Wchnschr., Sept. 9, 1921, 68, No. 36, 1144, in Jour. Am. Med. Assn., Jan. 7, 1922, 78, No. 1, 76.—"Gade states that, while pneumonoconiosis resulting from the inspiration of coal, metal, and mineral dust, and of vegetable material, in the form of flour and tobacco dust, has received widespread consideration in the literature, little has been said about analogous diseases resulting from breathing in the dust of wood fiber in saw mills, planing mills and similar industries. Under the microscope, the wood particles in the air are found to have many sharp edges and points. Under habitual inhalation of wood-fiber particles they set up a catarrhal affection of the respiratory passages, with many disagreeable symptoms and possibly disastrous results. Some wood fibers contain alkaloids and ethereal oils, which seem to produce an additional toxic effect. He therefore urges that greater attention be paid to the installation of mechanical devices to dispose of the dust, spraying, wearing of dust masks, ventilation, etc."—C. K. Drinker.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Certain Fundamentals in Early Diagnosis of Pulmonary Tuberculosis. *Lawrason Brown.* Jour. Am. Med. Assn., Jan. 14, 1922, 78, No. 2, 79-84.—"1. The diagnosis of pulmonary tuberculosis is in most instances more easily made today than formerly, but in the remainder such a diagnosis may tax the ingenuity of the cleverest physician.

"2. The diagnosis of pulmonary tuberculosis is not complete with the determination only of the presence of the disease, but must include also opinions about its activity, stage, and place and length of treatment.

"3. Pulmonary tuberculosis should be suspected in every case of blood spitting, pleurisy with effusion, persistent cough, undue fatigue, loss of weight, fistula-in-ano, or prolonged exposure to infection, whether in childhood or in adult life.

"4. It should be remembered that syphilis and tuberculosis respect no one.

"5. He who fails on examination to strip the patient to the waist may injure not only the patient but himself as well.

"6. He who would diagnose pulmonary tuberculosis early must be willing to pay for it in time and care and patience.

"7. Auscultation is vastly more helpful to him who is not fully proficient in the elicitation of physical signs than are percussion and inspection.

"8. The detection of râles is the most important factor in the physical diagnosis of early pulmonary tuberculosis.

"9. Failure to detect moderately coarse râles in pulmonary tuberculosis is due more often to ignorance of how to produce them rather than to inability to hear them.

"10. In early stages of the disease, râles are to be heard only after a simple or an expiratory cough.

"11. Persistent abnormal signs above the second rib and third vertebral spine, at one or at possibly both apexes, demand a diagnosis of pulmonary tuberculosis until it can be disproved. Conversely, such signs at one or both bases indicate nontuberculous disease until disproved.

"12. Stereoscopic roentgenograms, carefully taken and carefully interpreted, may reveal slight or extensive pulmonary tuberculosis which by ordinary methods of physical examination may escape detection.

"13. In any doubtful case, pulmonary tuberculosis should never be excluded without a careful roentgen-ray study.

"14. The presence of three or four or more tubercle bacilli in the sputum is the surest proof of the presence of tuberculosis in the respiratory tract.

"15. Repeated negative sputum examinations do not exclude pulmonary tuberculosis.

"16. It should be borne constantly in mind that any case in which no tubercle bacilli have ever been found may not be tuberculosis, and this fact should be emphasized always when extensive physical signs or a long history is present.

"17. Next to tubercle bacilli, the presence of moderately coarse râles or a parenchymatous roentgen-ray lesion above the second rib and third vertebral spine is the best evidence of pulmonary tuberculosis.

"18. Hemoptysis of a dram or more without heart disease or acute pulmonary infection, and idiopathic pleurisy with effusion, demand a diagnosis of suspected pulmonary tuberculosis and careful study.

"19. The five cardinal diagnostic points in pulmonary tuberculosis are tubercle bacilli, moderately coarse râles and a parenchymatous roentgen-ray lesion above the second rib and third vertebral spine, hemoptysis of 1 dram or more, and pleurisy with effusion.

"20. At least one or more of these points must be positive before a diagnosis of pulmonary tuberculosis can be made.

"21. If all five cardinal diagnostic points are lacking, a negative diagnosis in regard to pulmonary tuberculosis can be made; but in 1 or 2 per cent. we may be in error.

"22. A negative subcutaneous tuberculin test in an early case enables one to tell the patient that treatment at this time is not necessary.

"23. The diagnosis of clinical activity must be based largely if not entirely on symptoms and not on physical signs.

"24. Pathologic changes in the lungs can begin before any signs of clinical activity are present and continue long after all have disappeared.

"25. Cough and expectoration, and even in certain cases tubercle bacilli in the sputum, are not positive evidence of activity.

"26. Finally, one should imagine oneself in the patient's place, give his case the study one would ask for oneself, and not subject him to loss of time, of health and possibly even of life, by hasty conclusions drawn from carelessly collected and insufficiently considered data."—C. K. Drinker.

The Dietary Requirements in Pulmonary Tuberculosis. *William S. McCann.* Am. Rev. Tuberc., Jan., 1922, 5, No. 11, 870-875.—"1. Estimates of the total daily energy requirements of patients have been arrived at by determination of the basal heat production, making suitable additions for the effects of fever, food ingestion, and of coughing upon the metabolism.

"2. The difficult question of deciding upon the proper proportions in which the foodstuffs, protein, fat, and carbohydrate should be combined, has been approached by a consideration of the close interrelation of the metabolism with the respiratory and cardiac functions. The aim has been to devise a diet which will increase as little as possible the volume of respiration and the circulation rate through the lungs, in order to limit the functional demands upon an injured organ."—M. Dent.

The Pottery Industry and Tuberculosis. *Thiele.* Abstracted from Ztschr. f. Tuberk., 1921, 34, No. 3-4, in Hyg. Rundschau, Nov. 1, 1921, 31, No. 21, 671.—Since the reports from Jena, which brought into question the findings of Koelsch respecting the prevalence of tuberculosis as an occupational disease among workers in the porcelain industry, the industrial medical officer of Saxony has given attention to the same problem, and has reached the same conclu-

sion as Koelsch. He finds that 5 per cent. of 686 persons examined showed signs of tuberculosis of the lungs. More than 50 per cent. of the workers engaged over thirty years in the pottery industry suffered from "Staublungen." About the same conditions were found among earthenware workers; 6.44 per cent. had pulmonary tuberculosis and more than 30 per cent. "Staublungen."—G. E. Partridge.

THE DECREASE IN ANTHRAX MORTALITY IN ITALY. *G. Gherardi.* Il Lavoro, Nov. 30, 1921, 12, No. 7, 193-203.—Italy, a country predominantly agricultural, has always had an anthrax rate far above the average. In recent years, however, the combined effect of hygienic precautions and the therapeutic use of anti-anthrax serum have resulted in a reduction in the number of deaths from anthrax and in the proportion of fatalities from among anthrax cases.

Statistics of mortality reckoned in five-year periods from 1887 to 1916 show that the deaths have fallen from 20.8 per million of population to 6.2. This is for the whole country. The different regions show varying rates according as the agricultural part of the population predominates. Thus, during the period given above the rates for Calabria and Basilicata, which are purely agricultural, were 45 and 90.5 per million of population, while Venetia and Lombardy had rates of only 1.9 and 2. Throughout the whole country the mortality from anthrax during thirty years has been reduced to about one-third of the early figure, but this fall is much more marked in the purely agricultural regions of the south and southeast than in certain of the northern provinces where the rate has been either stationary or has even slightly increased. Thus, in the Emilia, in Tuscany and in Liguria the rate is maintained or even increased because the cities of Modena, Genoa, and Florence are centers for the importation of hides, or for the leather industries.

For the same reasons the anthrax rate for women has decreased more than that for men, since women are exposed to infection only in agricultural work, and, as we have seen, hygienic measures have been signally successful in this field, while the work of unloading, transporting and treating hides is carried on exclusively by men and is not as yet as well controlled.—Alice Hamilton.

TREATMENT OF ANTHRAX IN MAN. *R. Monteleone.* Abstracted as follows from Policlinico, Nov. 28, 1921, 28, No. 48, 1613, in Jour. Am. Med. Assn., Jan. 28, 1922, 78, No. 4, 314.—"Monteleone extols the fine results of antianthrax serotherapy, as he witnessed it in thirty-five cases. His research has confirmed that the anthrax bacilli lurk in the tissues to the farthest limits of the edematous zone, and hence cauterization is not effectual as it cannot be applied over this entire zone."—C. K. Drinker.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

OCCUPATIONAL DISEASES OF THE SKIN AND HANDS IN CALIFORNIA INDUSTRY. *Robert T. Legge.* Cal. State Jour. Med., Dec., 1921, 19, No. 12, 461-462.—Dermatitis among workmen consists usually in eczematous lesions, mainly the result of external irritation from exposure to dusts, chemicals and oils. "Flour, soot, cement, and sugar are typical examples and factors in simple dust irritants of the skin, while anilin and wood alcohol produce desquamative types, and machine oils and chlorin gas are examples of the group that result with pustules."

One occupational skin disease investigated was that among packers in a large tile and electric lamp manufacturing company. This disease was caused by an Arachnida known as the Pediculoides ventricosus, a tiny parasite which attaches itself to the skin by means of sucking disks and claws. To prevent further infection, fumigation by means of sulphur of the straw used for packing was advised. But with straw to be used in packing metals the sulphur process results in tarnishing the metals; in this case formaldehyde fumigation, followed by a thorough drying in the sun, is effective.

The second dermatitis investigated was that found among dried fig packers. This skin disease is attributed to the milky substance found in the stems, epidermis of the fruit, and in the latex tubes of the branches.

"Strasburger, a botanist, mentions that the latex cells secrete in the milky exudate a poisonous alkaloid, calcium malate and proteid granules." Among the fresh fruit pickers the symptoms sometimes appear in three or four hours, produce a stinging sensation, blister, and cause sanguineous oozing. "In the dried fig packers the symptoms are slower in developing, undoubtedly due to the drying by causing a destructive action of the enzyme, which is found normally in the latex of the ficus carica. The abrasive action on the cuticle of the hands of the operators when pulling open the dried figs permits directly this protein enzyme to produce a digestive and dissolving action of the tissues, and is the etiology that is responsible for the lesions."

Further investigations will be continued in the study and prevention of this seasonal occupational disease. In the meantime cotton gloves, or rubbing the hands with a high-grade mineral oil, such as the lighter automobile lubricants, are offered as preventive measures.—M. Dent.

Problems in the Care of Industrial Injuries of the Eye. *Howell L. Begle.* Jour. Mich. State Med. Soc., Nov., 1921, 20, No. 11, 443-448.—The author treats the subject under the following headings:

1. *Foreign Body in the Cornea.*—If the foreign body is not deeply imbedded, remove with a cotton swab in the first-aid room; if it is deeply imbedded, use the binocular loup and sharp spud, taking out all rust-stained tissue as well as the foreign body. If the patient complains much, use a solution of boric acid containing a few drops of 4 per cent. cocaine. Do not cover the eye with a pad. Follow up each case carefully, especially where there is any doubt about the cleanliness of the patient. If ulcers develop, cauterize with phenol, trichloracetic acid, or the actual cautery, according to the severity of the ulcers.

2. *Burns.*—More damage is done by burns than at first appears. In some cases mucous grafts from the lip should be placed over the burned area after removing the necrotic conjunctiva.

3. *Perforating Wounds.*—These should be handled with care. Some cases should not even be looked at except by a competent eye specialist. Gaping wounds of the cornea should be covered by a conjunctival flap.

4. *Traumatic Cataract.*—Operation should not be performed until the eye is white and quiet. The percentage of visual loss in an aphakic eye is at least 60 per cent.

5. *Sympathetic Ophthalmia.*—"An eye which has developed iridocyclitis after a perforating injury should be removed just as soon as it appears highly probable that there will be no useful vision. One should not trust in a two weeks' safety period." If after enucleation sympathetic ophthalmia does not develop within six weeks, one may feel fairly safe. Foci of infection should be sought for and removed.—H. G. Noyes.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Accident Prevention from a Medical Viewpoint. *W. H. Lipman.* Nation's Health, Jan. 15, 1922, 4, No. 1, 35-36.—"Industrial medicine is almost entirely a preventive undertaking. It aims, first of all, to prevent placing the wrong man at a given job or giving the wrong job to an applicant for employment—all of which is to the benefit of the applicant, the working force, and the public. Second, it attempts to prevent the spread of illness among employees either by periodic physical examination or by early treatment of sickness. Third, by promoting efficient care of accidental injuries, it prevents complications and reduces disability to a minimum. In reality this is nothing more or less than safety work; safety for the employee, for his family, for the employer, and for the public.

"Complete safety work is composed of two parts, one as indispensable as the other: (1) a more extended use of mechanical safety devices; and (2) a recognition of the importance of the human element before and after the accident, without which mechanical protection can only prevent a small number of accidents." In discussing this second important factor in safety work, Dr. Lipman emphasizes the importance of the attitude of the foreman and of the doctor toward the pre-

vention of accidents, and during the course of their treatment.

The foreman can help to bring home to the men his interest in safety if he sees to it that all injured persons, no matter how small the injury, are sent promptly to the doctor's office; if he displays interest in the injured man after the accident has occurred; and if he calls upon or especially inquires after men seriously enough injured to be absent from work. The foreman must never attempt to treat injuries himself, and should discourage fellow workmen from giving the injured person advice as to treatment.

The plant physician can contribute his part toward imbuing the men's minds with the advantages and desirability of safety work if he attempts to make the men feel not only confidence in his professional ability but also confidence in the fact that he is their friend and counselor. "He must make them feel that they can come to him with their accidents or their claims for compensation and receive the best kind of advice; advice that is fair both to them and to the company." He must treat the injured men like patients and not like "cases" in whom his only interest is to make an accident report.—Katherine R. Drinker.

Iron-Mine Accidents in the United States in 1920. U. S. Bur., Labor Statis., Month. Labor Rev., Nov., 1921, 13, No. 5, 1105-1106.—According to a preliminary statement 45,990 men were employed in the iron-mining industry in 1920, and reports from the iron-mine operators show that there were 106 deaths from accidents in 1920, and 9,072 non-fatal injuries—a decrease of 33 fatal and 26 non-fatal accidents as compared with the figures for 1919. These figures indicate a fatality rate of 2.34 per 1,000 men (300-day basis) and an injury rate of 200.49.

Of the 106 fatal accidents during the year, 76 occurred underground, 10 in shafts, 6 at open-pit workings, and 14 in surface shops and yards. Of the 9,072 non-fatal accidents, 6,565 occurred underground, 169 in shafts, 1,010 at open-pit mines, and 1,328 at surface shops or yards.—G. E. Partridge.

Accident Prevention in the Rubber Industry. *H. S. Poole.* Safety Engin., Dec., 1921, 42, No. 6, 254-259.—The more important phases of safety work particular to the rubber industry are discussed in this article, and are broadly classified under the following headings: fire, accidents due to small tools, hazardous machinery, and vapor poisoning.—R. M. Thomson.

What the Safety Inspector Must Do and What He Has Done. *J. G. Shaw.* Safety Engin., Dec., 1921, 42, No. 6, 260-262. —This article contains a discussion of the purposes and results of safety inspection work from the insurance companies' viewpoint.—R. M. Thomson.

Electrical Hazards Are More Dangerous than Mechanical Ones. *W. J. Pefferly.* Safety Engin., Dec., 1921, 42, No. 6, 265-268.—This article pertains to the electrical equipment in factories, and gives safety notes on the more common apparatus. —R. M. Thomson.

Safety Demands Americanization. *L. M. Stowell.* Safety Engin., Dec., 1921, 42, No. 6, 273-274.—This short article illustrates the positive need of systematic safety education in the shop in order to protect all workers from the indifference, ignorance and fatalism of a relative few in their midst.—R. M. Thomson.

INDUSTRIAL SURGERY

Dressing the Industrial Injury Correctly. *Virginia L. Montgomery.* Am. Jour. Nursing, Jan., 1922, 22, No. 4, 269-271. —The treatment and dressing of the minor industrial injury differ from the ordinary technic of the hospital in important ways. Reduction to a minimum of the loss of time by elimination of all unnecessary redressing and by strict attention to everything that can shorten the time of healing is of special importance to industry. Care must be used to attach the bandage firmly and to make it

adequate for protection, but at the same time as trim and as little bulky as possible. Often a double bandage may be needed, one to be removed when soiled. Using the common zinc oxide adhesive plaster, the nurse can with ingenuity overcome many difficulties. A bandage is a little thing, but of great importance to industry, and the science of its proper application is worthy of all the efforts of the industrial nurse if she would become of the greatest value to her employer. —G. E. Partridge.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

LENGTH OF WORK DAY AND INDUSTRIAL HEALTH. *Reynold A. Spaeth.* Nation's Health, Jan. 15, 1922, 4, No. 1, 32-33.—This article is a discussion of the difficulty—indeed, the impossibility—of determining by statistical investigations the ideal length of the working day. The problem, since it involves the health and happiness of human beings, and not solely the matter of maximum output, is a social-ethical problem, and not a purely scientific one. "The failure," according to Dr. Spaeth, "to distinguish clearly between these two levels—the unmoral and dispassionate scientific level and the social-ethical one—has led to a vast amount of controversy and misunderstanding." Sidney Webb perceived the real nature of the work-day problem thirty years ago when he wrote:

"The demand for shorter hours of labor has arisen among the working classes, not so much from the conviction that their present hours are injurious to health—though that in many cases is the fact—not so much from the theory that shorter hours mean higher wages—though that theory is in the main sound—but from the strongly felt desire for additional opportunities for recreation and the enjoyment of life."

Science can undoubtedly aid us in indicating the advantages of short hours in one industry and of long hours in another—especially, for example, in industries where we deal with 90 to 100 per cent. machine processes—but there is no universal right or wrong working day, which can be demonstrated statistically. In order to attain the maximum yield from labor, the elements of work must be proportioned to the physiological requirements of the workman. The speed of economical work must be determined by precise and specific studies in each industry, or, it may be, in each shop.—Katherine R. Drinker.

WOMEN AND CHILDREN IN INDUSTRY

STATE LAWS AFFECTING WORKING WOMEN. U. S. Dept. Labor, Women's Bur., Bull. No. 16, Washington, 1921, pp. 51.—This is a very useful summary of the various state laws affecting women's work. The survey includes the acts of the state legislatures and the regulations of state industrial boards which usually have the force of law. Not all the laws have been considered, but only those affecting the length of the working day and the total weekly hours; rest periods and time for meals; night work; home work; minimum wage; and mothers' pensions. Laws regulating working conditions have not been included, nor have laws forbidding employment in certain occupations, since there are a great number of these with wide differences among the states.

In addition to laws limiting daily hours in specified industries or occupations, five states have legislation supplementing the laws regulating both daily and weekly hours, and limiting only the weekly hours for certain industries or occupations. "A comparison of the charts will show that the states which have laws establishing the shortest working day and week are also the states which bring the greatest number of industries or occupations under the provisions of the law."

Nineteen states, the District of Columbia and the Territory of Porto Rico have pro-

vided for breaks in the working day, and so insure women against too continuous employment. Twelve of these states have limited the number of days that a woman may work in succession, in most cases to six out of seven. Fourteen states and the Territory of Porto Rico have provided that a period of time, varying from thirty minutes to one hour, is to be allowed for the noonday meal. Twelve states, also the District of Columbia and Porto Rico, have ruled that a woman can work only a fixed number of hours, usually five or six, without either a meal period or a rest period of some kind. Thirteen states and Porto Rico prohibit night work for women in certain industries or occupations.

No state has adequately protected its women, however, from injurious hours of labor, since a law needs to specify not only a definite number of hours per week but a definite number of hours per day and days per week. Neither a daily nor an hourly limitation alone is sufficient. Provision should be made also against too long continuous employment; simply to provide for a lunch period of definite length is not enough. The states which have industrial commissions are covering all these points more rapidly than those depending on separate acts of their legislatures for each step.

About one-fourth of the states have laws either prohibiting or regulating home work. Twelve states and the District of Columbia and Porto Rico have established a minimum wage for women workers. Forty states and two territories have mothers' pension laws.

Maps and charts make all the data of the survey available for detailed consideration. —G. E. Partridge.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Good Lighting at Low Cost. *F. I. Kinsman.* Factory, Jan., 1922, 28, No. 1, 106.—This short paper states that the cost of lighting for one firm was cut 60 per cent. by the installation of mirrored reflectors. It goes on to say that cutting down on lighting is wasteful economically as the workman's time is more expensive than the cost of increased lighting.—M. Dent.

Making Light out of Darkness. *M. R. Jacobs.* Factory, Jan., 1922, 28, No. 1, 102 104.—Few factories can, under normal conditions, get all the daylight that they require. One textile mill adopted a system of prism lighting which consisted "merely in substituting for the ordinary window glass a pane made of glass with a prism surface. These prisms will collect the light from all angles and refract it into the shop. . . . It is evident that it is quite necessary to have the prisms at the proper angles. Where there are a number of floors requiring the same intensity and direction of light, prisms must be varied to meet the conditions on each floor.

"In deep light wells or courts where there is almost never direct sunlight, glass canopies are used in addition to the prism window glass. They are placed over windows, and can be set at a particular angle to the walls, so that the light rays are drawn from the sky, received and controlled by the prism, and thrown directly into the interior of the building.

"Since these prism windows have been installed, this concern has been able nearly to halve its light bills, to say nothing of the better working condition, both for safety and increased production."—M. Dent.

Why White Walls Pay? *J. R. Rogers.* Factory, Jan., 1922, 28, No. 1, 96, 98.—A thorough study of the reflecting values of different colored paints in relation to white paint was made by a Detroit manufacturing firm with the following results: white 100 per cent.; light green 53 per cent.; light yellow 49 per cent.; light buff 44 per cent.; light gray 27 per cent.; brown 6 per cent.; and red 5 per cent.

Two charts are given, one showing the average hours a day of sunshine, cloudiness, and darkness for each month, and the other showing the number of deaths occurring from industrial accidents. On analysis, one finds that the largest number of accidents

occur during the darker winter months. It takes about four and a half times more electrical energy to light a plant with dark walls as it does to light the same plant with white walls. The difference between the actual cost of lighting in these two types of plants represents a saving which would easily pay for the cost of painting.

Finally, it is pointed out that good lighting contributes toward accident prevention and safety, and raises the whole morale of a plant. —M. Dent.

How Clean Windows Cut Cost. *P. J. Harrison.* Factory, Jan., 1922, 28, No. 1, 98, 100.—That diminished efficiency results from improperly cleaned windows was demonstrated when tests were made in one factory, where the windows were not cleaned for several months, which showed that fully 50 per cent. more light was admitted after a good cleaning. Not only is the cost of artificial illumination greater when windows are dust coated, but there is a bad psychological effect from dirt and gloom.—M. Dent.

Recommendations for Lighting Industrial Establishments. Mass. Dept. Labor and Industries, Jan., 1922.—A committee appointed by the Department of Labor and Industries has drawn up a proposed set of regulations to govern industrial lighting in the state of Massachusetts. The types of work included in the proposed regulations have been divided into eight classes according to the intensity of illumination required, and range from the minimum figures of 0.02 foot-candles for "roadways and yard thoroughfares" to a minimum of 7.00 foot-candles required for "extreme cases of fine work." The classification of the work under one or more of these eight divisions is to be determined by the inspectors, subject to review by the department.

Rules are suggested to govern the shading of lamps or working spaces, distribution of light on work, entrance and exit lighting, switches and controls, maintenance, and natural lighting.

The code is to be tried out by employers before being adopted, and a public hearing is to be held on May 16 for purposes of discussion and possible alterations. The committee emphasizes the importance of adhering to a uniform interstate code, and this proposed code differs but little from that approved by the American Engineering Standards Committee. Copies of the proposed code may be obtained from the Department of Labor and Industries, 473 State House, Boston.—Philip Drinker.

The Influence of Atmospheric Conditions on Industrial Efficiency. *H. M. Vernon.* Jour. State Med., Dec., 1921, 29, No. 12, 353-362.—Moving air, even if it contains a considerable amount of exhaled carbon dioxide, is more invigorating than pure but stagnant air. Hill's kata-thermometer is a fairly accurate device for measuring slight air currents. If the kata cools half as fast again as it does in still air, the air currents are moving at 50 feet per minute; if it cools twice as fast, they are moving at 142 feet, and if three times as fast, at 410 feet. Hambly and Bedford found in boot and shoe factories an average air velocity of 36 feet per minute, though in 10 per cent. of the shops it was 70 feet or more. Bedford and Vernon found in the badly underventilated potters' shops a velocity of 18 feet per minute in winter, and 29 feet in summer. The same is found in cotton weaving sheds.

The term "draught" is very indefinite, as it depends on the temperature of the moving air and upon the individual exposed. In shops where fairly active work is done the temperature should be between 60° and 65°, though it is necessarily higher in summer weather. Potters appear to have gotten acclimatized to a stuffy atmosphere, for at times, when investigators found it almost oppressive, they considered it "just comfortable."

There is no direct and exact proof of an influence of atmospheric conditions upon efficiency and productivity in many industries, but certain trades present very suggestive facts on this score. Vernon found a seasonal variation in the output of rolling-mill men in the tinplate trade, the average output in August being 10 per cent. less than in January. In intermediate months the output showed intermediate values which ran parallel with the mean air temperatures determined over the seven-year period investigated. It is argued that the installation of a thoroughly efficient system of ventilation in an

unventilated works might increase the average output for the whole year by about 12 per cent. Temperature effects restricted the outputs of laborers in open-hearth steel smelters, in steel rolling mills, in puddling wrought iron and in deep mines.

Acclimatization is another factor fixing the endurable limit of temperature. This is brought about by adaptation of the heart, the pulse rate not being so markedly accelerated; by reduction in the respiration rate; and by acceleration of the perspiration rate.

The question of humidity is especially important in linen and cotton weaving. The weavers show a considerable lowering of blood pressure as compared with other industrial workers, and there is little doubt that their efficiency is impaired by the atmospheric conditions under which they work.

Atmospheric conditions influence efficiency indirectly through the effect which they have on the frequency of accidents, as was found in two large shell factories during the War. Accident frequency was at a minimum at 67°; at temperatures below and above this point it increased rapidly. The optimum temperature for accident immunity is rather higher than that for working efficiency, but the frequency is only a little greater at 60° to 65° than at 67°, so that this is probably the best temperature range to aim at.

The high mortality in the potters' trade may be partly due to the overheated state of their shops, quite apart from the dust hazard also existing. The less the ventilation, the hotter and more humid the atmosphere, and the more crowded the shops, the greater the number of bacteria present; and every worker, healthy or unhealthy, thereby runs an increased risk of infection—and this risk is sometimes very great.—Barnett Cohen.

Providing Good Toilets. *R. B. Heathcote.* Factory, Jan., 1922, 28, No. 1, 116.—The B. F. Goodrich Company uses "8-foot units of white-enameled steel-ware equipped with five goosenecks provided with spray-heads about two inches in diameter, located 20 inches from the bottom of the lavatory, through which water mixed with steam flows with some pressure. Also between each gooseneck a liquid soap dispenser, of a tilting style, is attached, filled with a good quality of liquid soap." Other good features are that the lavatory units have no stoppers at the waste openings and that paper towels are furnished.—M. Dent.

Cleaning Cuspidors. *F. K. Douglass.* Factory, Jan., 1922, 28, No. 1, 112, 114.—The B. F. Goodrich Company describes the following method of cleaning cuspidors in the hope that the suggestions may be of use to other plants.

"A rectangular metal box is used for both collection and distribution, having a cover in four parts (this prevents exposing the contents of carriers to those not in sympathy with the tobacco habit), placed on a 4-wheel truck and made demountable in order that the load, box included, may be promptly removed from the truck, and a load of clean cuspidors started on its tour of distribution and collection.

"Cuspidors are emptied into a digestor composed of a 1/4-inch screen receptacle placed over a sewer opening, all of which is surrounded by a metal cylinder with foot-operated cover. When the solid matter has filled the screen receptacle it is removed from the cylindrical envelop and an empty clean one replaces it, the full screen being emptied into a garbage can and covered, ready for final disposition at the incinerator.

"The cuspidors after being emptied at the digestor are passed to a bench provided with racks properly equipped with pegs on which to set the bowl and covers of cuspidors. These racks are then placed in a machine which is provided with warm water into which has been placed a washing solution. The water is pumped into the cuspidors through rapidly revolving sprays with considerable force. When this washing is done, which requires about 1½ minutes, the pump is stopped and a douche of steam and hot water is thrown on them, thereby rinsing them of the washing solution, and thoroughly cleansing and disinfecting the cuspidors. They are then removed from the trays and placed in the rectangular box, and are ready again for distribution. Of course, when trays are removed from the machine, four more trays replace them, and so on in multiple. The cuspidors used in this factory, about 5,000 in number, are made of galvanized metal, about 9 inches in diameter, with removable top which is concave with a 2-inch opening. All cuspidors are cleaned every day."—M. Dent.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Health Service for Seattle Building. *Helen A. Carnes.* Hosp. Management, Dec., 1921, 12, No. 6, 56, 58.—The Metropolitan Building Company has adopted a policy of hiring employees who are fit, of trying to keep them fit while they are working for the company, and of caring for them when they are ill. The company has a doctor who examines every applicant for work and decides what position he or she is physically able to fill. Old employees are given periodical physical examinations and advice as to treatment, if any is necessary.

In examining an employee, the doctor takes a brief family history, a personal history, height, weight, pulse, temperature and blood pressure, examines the nose, throat, heart and lungs, and makes an analysis of the urine and a careful record of all defects. All findings are entered on the examination blank. If any recommendations are made, the personnel department sees that they are followed out.

The company pays employees for absences on account of illness after they have been employed six months and after the third day of illness. It also maintains a small summer camp where employees may spend their vacations rent free. The company sees a return for all these benefits in increased enthusiasm and co-operation on the part of employees, and in lessened absenteeism and labor turnover.—M. Dent.

Health Service of Stetson Company. Hosp. Management, Dec., 1921, 12, No. 6, 60, 62.—The John B. Stetson Company of Philadelphia has every comfort and health provision possible for its employees. These provisions include factory and office buildings of modern construction, with maximum light and ventilation, cafeterias, rest rooms for women, first-aid room, dental department, and a sixty-bed hospital.

The first-aid room is supervised by a graduate nurse and her assistant. Minor accidents and ailments are treated there; serious cases are sent to the hospital or cared for by the medical director. The company medical director has daily office hours at the plant, and employees may call for advice and medicine for the sum of 50 cents.

Dental service is available from 9 o'clock to 5 o'clock, two dentists being in attendance, one in the morning and one in the afternoon. A small charge is made for dental service also.

The health service has a visiting staff consisting of a welfare worker and a graduate nurse, who visit all employees after they have been absent two days. The Stetson hospital gives general service besides caring for employees. Only 13 per cent. of all patients cared for in the hospital in 1919 were employees. An employee may have a free bed in the ward or in a semi-private ward, or he may pay; a deduction of one-third the usual charge is made for him if he wishes to pay.—M. Dent.

Health Service of Armour & Co. Hosp. Management, Jan., 1922, 13, No. 1, 58, 64.—Armour and Company make no pretense of being actuated by benevolence in maintaining their employee health service, but do so from purely business motives in an endeavor to reduce time lost, absenteeism, and labor turnover.

The Chicago plant of the company has a large, centrally located and well-equipped hospital with a personnel of twelve, which includes an X-ray specialist and a dentist. Employees are instructed in hygiene and care of the health. The dental work done by the company is mostly prophylactic and advisory, dental work being advised if serious conditions are found. If the employee is not financially able to have the work done, the necessary funds are advanced by the company.

A gymnasium for men, rest rooms for girls, corrective exercises, and aesthetic and folk dancing for girls are some of the different kinds of health service rendered. Any worker who has illness in his family may request the company physician to visit his family. The company also assists in the maintenance of a sanatorium in Arizona for tuberculous employees.—M. Dent.

An Industrial Emergency Hospital. *Bert T. Barnes.* Nation's Health, Jan. 15, 1922, 4, No. 1, 37.—This paper is a brief description of the equipment and work of the emergency hospital at the ship and repair yard of the Morse Dry Dock and Repair Company, Brooklyn, N. Y. The author emphasizes especially

the continuous day and night service and the follow-up work of this hospital; the effort to give medical treatment to all injuries, no matter how trivial; the utilization of specialists in cases requiring unusual attention; the visiting of employees' families by the hospital nurses; and the co-operation between the hospital staff and the editors of the employees' magazine, in their mutual efforts to promote safety work.—Katherine R. Drinker.

1921 AND THE INDUSTRIAL HOSPITAL. *Sanford DeHart.* Hosp. Management, Jan., 1922, 13, No. 1, 56-57, 64.—Many industrial hospitals were curtailed in 1921 for the following reasons:

1. The business depression.
2. Over-expansion of the hospital department. Sometimes the personnel comprised not only doctors and nurses, but also physiologists, osteopaths, etc.
3. Because the physician or nurse failed to keep the plant manager informed by weekly or monthly reports of what the hospital was accomplishing. When the manager knows what is being done by the hospital he is not slow to see the humane and economic advantages of such an institution.

The physician or nurse of an industrial hospital is doubly valuable because he or she has gathered a knowledge of the principles governing accident prevention and modern manufacturing methods and can make remedial suggestions so that the same injury will not occur twice.

In the R. K. LeBlond Tool Company the accident prevention work was placed under the supervision of the medical department three years ago. The remainder of this article points out how the co-operation between the medical and engineering departments has resulted in increased efficiency and safety within the plant. One example will suffice to illustrate this point. Traumatic conjunctivitis, blepharitis and keratitis were especially prevalent in one department. A conference was called between the medical and engineering departments with the result that a safety guard was installed which has entirely eliminated this hazard.—M. Dent.

INDUSTRIAL NURSING

INDUSTRIAL NURSING AS A MEANS OF FIGHTING TUBERCULOSIS. *Lee K. Frankel.* Pub. Health Nurse, Jan., 1922, 14, No. 1, 3-7. —This is a very general discussion of the possibilities for good in the work of the industrial nurse (including both the shop nurse and the nurse of the visiting nurses' association) as an educator, in close contact with both the public and the industrial management, and bringing to the employer a knowledge of the home conditions of his workers. It is the business of the industrial nurse to know the needs of the workers, not merely during the hours of work, but at all times, and to see that industry takes proper care of its workers and extends its interest to all the conditions upon which welfare and efficiency depend.

One of the natural results of such general oversight will be the periodic health examination, and then we shall be able to find tuberculosis in its earliest stages and can apply treatment with every probability of cure. The results of the experiment in Framingham where two-thirds of the population were examined show that at present not nearly all of either the early or the advanced cases of tuberculosis are being reached.

The work of the Metropolitan Life Insurance Company of New York shows what may be done. There are approximately 275 employees working in the New York office, all of whom have had tuberculosis, and have had treatment at the company's sanatorium. These cases were discovered because the company requires periodic medical examinations. The nurses, by going into the homes, help to find the early conditions producing tuberculosis. Eighty-five per cent. of those treated at the sanatorium have been returned to work with the disease corrected.

As a further illustration of what may be accomplished by adequate attention to the whole problem of the employee, the welfare work of a large industrial concern in the South is mentioned, which employs fifty

physicians and a large number of nurses and has a hospital on which it is spending a million dollars. It is a part of the work of this system to extend care to the families of the workers at all times, not merely when there is sickness.—G. E. Partridge.

INDUSTRIAL PERSONAL AND COMMUNITY HYGIENE: HOUSING, ETC.

How Health Talks Help. *T. E. Raymond.* Factory, Jan., 1922, 28, No. 1, 112.—The author sets forth the advantages of occasional short health talks to employees, reminding them of the fact that personal hygiene is necessary to health. An example of such a talk is given.—M. Dent.

Creating Interest in Health. *J. R. Jacobs.* Factory, Jan., 1922, 28, No. 1, 108.—In this plant pamphlets and posters upon the bulletin board had failed in the past to arouse any interest in health. The doctor thereupon devised a plan to divide the plant clubs into teams between which a health competition should be held for the period of a month. "Cards were given all members containing the information and rules. Daily exercise, gymnasium work, swimming, 8 hours' rest at night, proper diet, sleeping in the fresh air and general care of the body were counted. The perfect score was 100 and failure to observe the rules was checked by a committee each day."

The plan succeeded admirably and general interest in health was spread throughout the plant.—M. Dent.

INDUSTRIAL INVESTIGATIONS AND SURVEYS

Motion Study in Metal Polishing. *E. Farmer*, assisted by *R. S. Brooke.* Indust. Fatigue Research Board, Report No. 15, Metal Series No. 5. His Majesty's Stationery Office, London, 1921, pp. 65.—This report embodies the results of an extensive investigation into the possibilities of applying motion study methods in the buffing trade. "The effects on output and fatigue are clearly indicated, and certain principles are suggested, not confined to the particular process investigated but immediately applicable to all trades in which the grinding or polishing of metal is carried on." The substance of the report is summarized as follows:

"1. By close observation of the movements of a number of emery wheel filers, provided with seating, glass screens and contoured rests, the unproductive time was considerably reduced. Then by training, and the institution of a team in the case of 'set' forks, the output in two shops increased without any apparent increase of effort on the part of the workers.

"2. The design and provision of seats for outside dolliers were arrived at after a close study of an individual worker on a wide variety of work over 6-day periods, standing and seated. The effects of seating resulted in greater buoyancy in the workers, and the output seated is slightly higher than with continuous standing. . . . .

"3. The methods of work and movements of a number of outside grease dolliers were systematically observed. Astonishing differences were noticed between workers with long years of experience. Eventually a systematized set of movements was employed in a training scheme which resulted in great improvement in the work and piece-work earning of many of the older hands. This training with novices in a few days enabled a standard efficiency to be attained hitherto said to be attained only after months of practice.

"4. A similar study of the movements in roughing had also satisfactory results when applied to a training scheme, although in this process a longer time is required to attain proficiency on account of the more complicated movements. The attempt to reduce the number of strokes, to do more work with the hands and less movement with the body, quickly leads to a more rhythmic use of human energy with increased comfort to the in-

dividual and improved quality of the work.

"5. The process of glazing on wheels dressed with emery was under observation, and although the material side of the question is somewhat outside the scope of this investigation, the change of practice, by relieving some of the more strenuous work of roughing, gives a noticeable relief to the worker and considerably reduces the rosining required to keep the roughing wheels in condition. This glazing of the edges of spoons and forks is of special interest, as it is one of the chief differences between French and English practice.

"6. A recording wattmeter connected with a separate motor driving an individual wheel enabled a graphical illustration of every separate movement, and an approximate estimate of its duration and strength, to be obtained. These records for the moment have been specially directed to observing the incidence of fatigue at different periods of the day's work.

"7. Since in actual practice no worker can continuously perform any operations of the nature of polishing throughout a working day without suitable rest pauses, an attempt was made to study the effect of artificially introducing regular pauses each hour and comparing the time thus allowed and the effect on the work with the time voluntarily taken by a steady worker.

"8. Attention is drawn to some preliminary results obtained by running an insiding buff at different speeds."

From the findings reported it is concluded:

"1. A definite course of training should be given to all workers who enter the buffing trade, instead of allowing them to pick up their trade as best they can.

"2. This course of training should be based on the principles indicated in this report. No claim is made that they represent a final stage of perfection, but only that they are more satisfactory than the traditional methods.

"3. Further experiments should be carried out in the buffing trade. Among the problems which require research is that of vibration. . . . The connection between rhythm, fatigue and rest pauses should be more carefully examined.

"4. Efforts should be made on the technical side to devise an abrasive which is less dusty and dirty than loose sand, and not so coarse as an emery wheel.

"5. Seats should be provided for the workers and their benches should be modified in such a way as to permit the use of the seats without discomfort being caused by inadequate space for the legs.

"6. Further research should be carried out on the proper size and breadth of wheels and the most economical speed at which they should revolve."—M. C. Shorley.

An Investigation into the Packing of Chocolates. *E. Farmer* and *A. B. B. Eyre.* Jour. Nat. Inst. Indust. Psychol., Jan., 1922, 1, No. 1, 12-16.—Fatigue in chocolate packers is mental rather than physical, as the chocolates have to be packed in such a way as to produce an artistic effect. By introducing a new type of bench and arranging the varieties of chocolates in a more convenient way for selection, so as to increase the rhythm of the movements and diminish the need for voluntary decisions, the output was increased 36 per cent., though part of this improvement was due to the maintenance of a more regular supply of chocolates. The hourly output curve, previous to the improved conditions, showed a rapid fall during the course of the afternoon spell, but subsequently it kept at a steady level, presumably because of a reduction in fatigue.—H. M. Vernon.

An Investigation into the Tin-Box Industry. *E. Farmer* and *R. St.C. Brooke.* Jour. Nat. Inst. Indust. Psychol., Jan., 1922, 1, No. 1, 9-11.—Conditions which induced unnecessary fatigue in the workers were investigated, and in consequence many small improvements in the manufacture of tin boxes were introduced. For instance, the size of the piece of short metal supplied to the workers was found to be unsuitable. On substitution of a better size, a saving of time amounting to from 30 to 40 per cent. was effected in some instances. The sheets of tin were not kept at the right height, and the girls had to stoop to pick them up. By placing the sheets on a box, the stooping was avoided, and the time of the complete stamping operation was reduced 9 per cent. Again, some girls were found to be more expert at soldering round boxes than angular boxes, and others showed the opposite capacity; they were, therefore, sorted out and put on

the process at which they were most efficient. Other experiments in seating and in rest pauses were carried out, with useful results.—H. M. Vernon.

INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

THE HUMAN FACTOR IN INDUSTRY. III. *C. H. Northcott.* Indust. Management, Dec., 1921, 62, No. 6, 363-369.—This is a general study of the instincts and desires displayed in industrial life, with the practical conclusions for industry based upon the following propositions: (1) The springs of human action lie in instinctive predispositions which experience hardens into desire or aversion, and habit consolidates. (2) A normal and healthy life is dependent upon adequate satisfaction of these innate tendencies. (3) The balking or repression of these impulses causes disquiet, agitation, or some direct form of perverted conduct.

The most powerful instinct in industrial life is the gregarious instinct, and very closely related to it is the tendency to sympathetic emotion. Another important element is the impulse to gain leadership and mastery—and the capitalistic system is based largely on the cultivation of this instinct, which has greater strength when the more elementary desires have obtained satisfaction. Contrasted with this instinct is that of submission which prompts men to follow a leader. Analysis of industrial life shows other instincts, such as the creative or self-expressive instinct, appearing as an instinct of workmanship; the instinct of pugnacity; and the instinct of fear.

These instincts are powerful and urge toward expression; their repression is followed by many manifestations of disturbance. "Unlike the unused muscle they do not die of inanition." Inner conflicts are caused, and one of the most natural results of repression is anger.

There is much in industry that is repressive of the instincts. The gregarious instinct is repressed by every effort to destroy collective bargaining and every refusal to receive accredited representatives of workers. Modern conditions of industry deny the opportunity of leadership to most men. Modern industry is repressive in that it tends to suppress initiative and to discourage responsibility and self-direction. The atmosphere is mainly one of opposition. A process of modification of instincts, and hardening into habits is constantly going on, so that if we think of the behavior of man as merely a clashing of instincts we leave out one essential fact.

If the repression of instincts were final and irrevocable, nothing but disaster could result. The hope of a peaceful future lies in the alteration of the character of industry under the guidance of intelligence. Industrial engineers have set about the gradual changing of industry in the direction of the normal expression of human nature. They have shown that the gregarious instinct can receive due recognition, and it is now being demanded that industry shall afford an opportunity for the development of personality and of a full and satisfying life. It is required of industry that it become a medium for education and experience, and the means by which personal intelligence, initiative and sense of responsibility may be increased. These are demands made by the workers themselves, and arise from a clear perception of their own needs.—G. E. Partridge.

A COMPARISON OF SPEED WITH ACCURACY IN THE LEARNING PROCESS. *Mary Sturt.* Brit. Jour. Psychol., Dec., 1921, Vol. 12, 289-300.—It was formerly maintained that in learning habits involving muscular activity it is better to insist at the outset on accuracy rather than speed. Gilbreth has recently controverted this view, and maintains that speed, not accuracy, should be insisted on, for he points out that slow movements are inevitably different in form from (the same) fast movements. The question was put to a practical test with two groups of ten girls, all of them aged 12 to 14. They were selected from large groups on the strength of similar performances in various tests (memory, spelling, etc.). The groups were at different schools, so that they could not discuss the experiment with one another. Each subject was given two half-hours' teach-

ing a week in typewriting for sixteen weeks. The subjects at one school were told that speed was the important consideration, and they were given marks and prizes simply for speed; while the other group were told to aim at accuracy, and their papers were returned to them, corrected for mistakes, but with no mention of speed. Then for six weeks the instructions given to the two groups were reversed, and it was found that almost immediately the "accuracy group," though previously much slower, attained the same speed as the former "speed" group, but the speed group did not attain the accuracy of the former "accuracy" group till the end of the six weeks. Hence it appears that, so far as typewriting is concerned, the same speed is obtained finally whether or not speed is insisted on at the start. Also it seems probable that a high quality of work can be obtained finally, without insisting on a high quality throughout the learning process. Still, it seems unwise to demand speed from the very beginning, as it becomes more difficult for the learner to acquire correct movements.—H. M. Vernon.

TESTS FOR CLERICAL OCCUPATIONS. *Cyril Burt.* Jour. Nat. Inst. Indust. Psychol., Jan., 1922, 1, No. 1, 23-27.—A very elaborate set of tests for clerical occupations is described, which includes graded tests of intelligence and educational attainments, *i. e.*, tests of linguistic ability and general information, and numerous tests of speed and accuracy in typewriting and shorthand. The whole series takes about two hours, and was applied to thirty typists in the office of an Education Authority. The results of the test agreed very closely with the general views of the supervisor, and it was possible to deduce from the individual performances a list of minimal standards of merit (1) for those capable of work of a high order of intelligence; (2) for those capable of merely mechanical work; (3) for those at present unfit for practical work, but likely to become capable after further training; and (4) for those incapable of shorthand and typing. Detailed correlations will be published later.—H. M. Vernon.

INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

LECTURE CONFERENCE FOR WELFARE SUPERVISORS. Industrial Welfare Society, London, 1921.—This publication reports the proceedings of the second annual conference of the Industrial Welfare Society, which was held at Balliol College, Oxford. Conferences such as this were inaugurated during the War by the Welfare and Health Section of the Ministry of Munitions. Their success has led to their continuance; indeed, a further conference was held (also at Balliol College) by the Welfare Workers' Institute in January of this year. The value of these conferences, where the members attending live together for several days in college, meet one another for exchange of views, and hold informal gatherings at any moment, is far greater than can be evaluated by merely reviewing the lectures and addresses given.

The conference was opened by Lord Gorell, first chairman of the Miners' Welfare Committee (now succeeded by Lord Chelmsford, late Viceroy of India). He dwelt upon the unique way in which, under the Mining Industry Act, the welfare movement is being spread throughout the coal fields, and in the course of a scholarly address emphasized the importance of education to industrial welfare. Dr. Gorell spoke from his experience in organizing education for the army, and from the benefit which has resulted. That way leads to knowledge, at once the foe of unrest and the foundation of sound practice. Mr. C. D. Burns discussed economic history, with special reference to industry and to the factors concerned with industrial legislation in the nineteenth century. He showed how each advance was a step on the road to the welfare movement, by which a man should be able to find his humanity, not merely in leisure, but in his actual work. The next lecturer was Mr. E. Farmer, who dealt with industrial psychology, a subject bound to come to the front once the individuality of each worker receives attention. Stress was laid on the need for separating this subject from that of the economies of production. Efficiency may and, indeed, is bound to result, but efficiency should not be the only objective. The individual, his capacity and natural rhythms, and the way in which physical energy can be conserved and not

wastefully expended, should come first. Unprofitable industrial disputes are often based on psychological irritation, an irritation resulting from wasteful expenditure of energy; while industrial accidents are frequently an outward sign of the same inward and mundane *ennui*. Here vocational selection, occupational training and motion study are needed to enable the worker to find in his work an intellectual service, in place of a monotonous routine.

The subject of camps and camping was introduced by Mr. R. S. Wood. He told how last year railway vouchers had been issued to nearly 100,000 young persons travelling to camps, but that far too few were issued to boys industrially employed; and he impressed upon his audience the value of camp life for creating a spirit of comradeship, discipline, good form and good tone, in addition to a tradition of open-air life and of enjoying the out-of-doors. Dr. C. W. Kimmins was in his element in pressing the educational possibilities presented by the new day-continuation scheme just launched in London and elsewhere. He pointed out that welfare supervisors had here a magnificent opportunity of applying modern educational methods and, through research, of obtaining an idea of the make-up and special aptitudes of juveniles. In this way a necessary link between education and industry could and should be forged. The value of folk dances and music in recreation was made manifest by Mr. C. J. Sharp, who told of his discovery of a bit of Elizabethan England still existing in the center of the United States, where an illiterate and isolated community had preserved the songs and dances of "Merry England." This happy people, who knew how to play and live abundant lives, had retained an art nearly lost by modern industrial peoples. Folk dances and folk songs should be preserved and taught again; they are quickly learned because they are in the blood; they supply an outlet for faculties not exercised at work, and this is the true object of recreation.

The attitude of labor toward industrial welfare was the subject of a pronouncement by Mr. F. Bramley. He laid his hand on the cold Marxian doctrine that improvements which tend to make industrial conditions under capitalism more tolerable only perpetuate a wrong economic system, and declared it not merely moribund, but dead. He welcomed welfare and all means of health culture as advantageous to physical and mental development. By this means may be broken down the antagonism and suspicion only too prevalent today between employers and workers; for welfare work cannot be successful without the consent and goodwill of both workers and employers. He promised the movement the unqualified support of organized labor. This address, which should be read as published, was one of great importance, and marks the great advance made from the semi-veiled or open opposition of only four years ago.

Sir Andrew Duncan, who followed, spoke from the employer's point of view and pointed out that welfare was a movement on the part of industry itself, not driven thereto by legislation; it represented a practical problem for attack. He placed the inside-the-workshop aspect first, by which means men might come to say that they loved for its own sake the work which provides their livelihood. Welfare should start with the juveniles, to whom men should show example in craftsmanship and conduct, and employers should extend sympathy and encouragement during apprenticeship in craft training and craft discipline. In relation to outside-the-workshop activities, the employer only functions as any other citizen to maintain the spirit of welfare which endures whether times be good or bad. He held that the welfare of those employed was an obligation or burden which industry cannot afford to pass on entirely to other aspects of communal life and citizenship.

The last address was delivered by Professor E. L. Collis, who, in dealing with the health of the industrial worker, pointed out certain broad principles of health and the way in which welfare supervisors can act as apostles of preventive medicine. In so doing, he touched upon the importance of ventilation, personal hygiene, drinking water, food and light, as well as the rules underlying activity and fatigue. He, like the previous speaker, laid stress on the paramount importance of inside-the-workshop conditions, and warned his hearers against devoting too much time to the more showy and attractive subject of recreation.—E. L. Collis.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

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GENERAL

INDUSTRIAL HYGIENE. *T. Oliver.* Abstracted as follows from Colliery Guardian, 1921, Vol. 122, 307-308, by C. C. Davis, in Chem. Abstr., Feb. 10, 1922, 16, No. 3, 451. —"An address dealing with CO poisoning and other industrial hazards."

THE PROBLEM OF INDUSTRIAL HYGIENE AND THE CO-OPERATION OF PHYSICIANS IN INDUSTRIAL SUPERVISION. *H. Rasch.* Zentralbl. f. Gewerbehyg., Sept., 1921, 9, No. 9, 185-190. (Conclusion of article; the first part was abstracted in THIS JOURNAL, Jan., 1922, 3, No. 9, 205.)—Supervision of conditions in the factory and in the surrounding community should be entrusted to the same official. Industrial hygiene cannot dispense with the constant participation of physicians, acting with the technical inspectors and administrators. The plans used in Hamburg are outlined as examples of how physicians may participate in several ways in such work.—E. L. Sevringhaus.

THE PROBLEM OF INDUSTRIAL HYGIENE AND THE CO-OPERATION OF PHYSICIANS IN INDUSTRIAL SUPERVISION. *Holtzmann.* Zentralbl. f. Gewerbehyg., Sept., 1921, 9, No. 9, 190-192.—The author reiterates and emphasizes the arguments presented by Rasch in his paper by the same title, which is reviewed in the preceding abstract.—E. L. Sevringhaus.

DRAFT CONVENTIONS AND RECOMMENDATIONS ADOPTED BY THE THIRD SESSION OF THE INTERNATIONAL LABOUR CONFERENCE. Internat. Labour Office, Official Bull., Dec. 7, 1921, supplement to Vol. 4, No. 23, pp. 26.

—The Draft Conventions and Recommendations included in this number of the *Official Bulletin* are listed below for the benefit of interested readers:

Recommendation concerning the prevention of unemployment in agriculture.

Recommendation concerning the protection, before and after child-birth, of women wage-earners in agriculture.

Recommendation concerning night work of women in agriculture.

Draft Convention concerning the age for admission of children to employment in agriculture.

Recommendation concerning night work of children and young persons in agriculture.

Recommendation concerning the development of technical agricultural education.

Recommendation concerning living-in conditions of agricultural workers.

Draft Convention concerning the rights of association and combination of agricultural workers.

Draft Convention concerning workmen's compensation in agriculture.

Recommendation concerning social insurance in agriculture.

Draft Convention concerning the use of white lead in painting.

Draft Convention concerning the application of the weekly rest in industrial undertakings.

Recommendation concerning the application of the weekly rest in commercial establishments.

Draft Convention fixing the minimum age for the admission of young persons to employment as trimmers or stokers.

—M. C. Shorley.

SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

CENTRAL NERVOUS SYSTEM

Post-Traumatic Neuroses: Their Mechanism. *Joseph Catton.* Calif. State Jour. Med., Dec., 1921, 19, No. 12, 468-471.—In this address, delivered before the Fiftieth Annual Meeting of the Medical Society of the State of California, Dr. Catton presents the attitudes of the three schools of thought which have developed as a result of the efforts to explain the basic mechanism of the mental and nervous disturbances following physical trauma. The first school holds that there is a definite organic basis for the phenomena; the second, that the disease pictures rest on a psychogenic and nonorganic basis; and the third is made up of investigators who have varying opinions including organic and psychogenic features.

The following suggestions are made in the hope that they may indicate lines of investigation:

"Differential symptomatology should be worked out as between the frank and less frank organic conditions, the latter of which have been termed functional.

"Surveys should be made of the after-histories of accident cases thought to have been settled by the 'lump sum closure method.'

"Early complete examinations should be made in order to detect localizing organic signs which may later disappear.

"Experimental work on animals should be continued as regards injuries to the nervous system following physical trauma with or without external evidences of injury."—M. C. Shorley.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Diffuse Hemorrhage of the Heart Musculature in a Case of Poisoning by Illuminating Gas. *Georg Strassmann.* Wien. klin. Wchnschr., 1921, Vol. 34, 483-484.—This rather rare occurrence is believed to have been due to the abnormal constitution of the individual described.—Barnett Cohen.

The Occupational and Medical Review of Wood Spirit or Methyl Alcohol. *F. Koelsch.* Zentralbl. f. Gewerbehyg., Sept., 1921, 9, No. 9, 198-203.—This article presents a review of the symptoms and the types of cases of methyl alcohol poisoning, the methods of absorption of the poison, and the necessary precautions.—E. L. Sevringhaus.

Hazards in Working with Denatured Alcohol. Burnisher's Eczema. *F. Koelsch.*

Zentralbl. f. Gewerbehyg., Sept., 1921, 9, No. 9, 203-207.—The eczema of burnishers occurs among those using alcohol denatured with methyl alcohol, pyridine, or turpentine. The cause is not decided. It may be due to the removal of the fat and water from the skin by the alcohol itself, and by the use of the strong soap for cleansing. Simple rules for treatment are given.—E. L. Sevringhaus.

THE IMPENDING PROHIBITION OF THE USE OF WHITE LEAD AND THE METHODS OF BLOOD STUDY AS A DEFENSE. *Johannes Schoenfeld.* Zentralbl. f. Gewerbehyg., Nov., 1921, 9, No. 11. 256-264.—A variety of industries would suffer severely if the use of white lead were prohibited. The conservation of health does not demand such a step. Study of the blood has made diagnosis so much more accurate that the effects of lead can be detected before clinical signs appear. Experience of the author and of others is cited to show how early diagnoses are made and how affected individuals are cured. The author considers thirty basophilic staining red cells per million evidence of lead influence, although no intoxication may have taken place. He believes polychromatophilia to be even earlier as a sign of lead influence than the basophilic degeneration.—E. L. Sevringhaus.

LEAD POISONING AND THE INTERNATIONAL LABOUR CONFERENCE. *H. E. Armstrong.* Brit. Med. Jour., Dec. 17, 1921, No. 3181, 1042-1044.—A question arising at the Geneva Conference was whether medical science was in a position to diagnose lead poisoning properly, and the report received stated that only specially trained medical men could diagnose saturnism.

The writer complains that his efforts at the Conference to bring into the discussion the effects of volatile thinners were thwarted, and that the medical subcommittee reported that, as far as painters using white lead or other lead compound are concerned, saturnism is the chief risk (although the statistics are vitiated in several ways), and that by far the most important danger is from dust that enters through the nose and mouth.

The dust produced by dry rubbing down is the chief risk in painting, and if this is eliminated and careless work deprecated there should be little objection to house-painting as an occupation. The risks from lead poisoning in the white lead and the pottery industries have been nearly abolished by the introduction of mechanical methods of removing dust and by wise regulations. It is also proved conclusively that volatile compounds of lead are not given off by paint as has been so often asserted. Turpentine, on the other hand, is a cause of poisoning which has often been attributed to lead. In fact, all solvents of oil which can be used as thinners in paints and varnishes are lethal substances, and there is danger in repeated and continued exposure to small amounts of turpentine and similar substances.—G. E. Partridge.

INDUSTRIAL POISONING IN MAKING COAL-TAR DYES AND DYE INTERMEDIATES. *Alice Hamilton.* U. S. Dept. Labor. Bull. No. 280, 1921, pp. 87.—This report on the hazards from poisoning in the industries using coal tar dyes and intermediates is based in part on inspections of plants in the United States and in Europe, and in part on a study of all the available literature dealing with the subject. There is a brief historical review indicating the rapid change from crude and careless practices to the present stage of efficiency, a stage which, however, leaves room for much improvement. The fullest treatment is given to the benzene derivatives, but phosgene, the aliphatic compounds and inorganic compounds are also reported on. Lists of the substances that are shown to be harmful by the reports of factory inspectors both in the United States and Germany are given, with other data and a summary of the experiences of the two countries. The various processes used in manufacture are described in outline, since "it is impossible to generalize about the dangers of the color industry." There is a section on prevention of occupational poisoning, and the following topics are treated in the five appendices: structure of the benzene ring and its principal derivatives; products derived from coal (chart); rules and regulations suggested for safety in the manufacture of benzene derivatives and explosives (for Massachusetts); safety standards for the manufacture of nitro and

amido compounds adopted by New Jersey and Pennsylvania: regulations for the manufacture of nitro and amido derivatives of benzene and of explosives with use of dinitrobenzol or dinitrotoluol.

The subject, as presented by the author, is far too complex to allow brief summarizing. The paper should be read in its entirety by all interested in its topic.—G. E. Partridge.

Value of Calcium Sulfide in Bichloride of Mercury Poisoning. *S. W. Sappington* and *G. A. Hopp.* Abstracted as follows from Hahnemannian Monthly, 1921, Vol. 56, 753-761, by J. S. Hepburn, in Chem. Abstr., Feb. 20, 1922, 16, No. 4, 590.—"Of 22 rabbits in which Hg was given as a poison and CaS as an antidote, 18 died, 17 within 5 days and 1 on the 6th day. Of the remaining 4 live rabbits, 1 was given a neutral test-tube mixture of poison and antidote, another had the antidote poured immediately on top of the poison in the stomach, a third survived after an intravenous injection and a fourth after excessive doses of CaS by the stomach. Only 2 of the 22 rabbits could, in the practical sense, be said to have been saved by the antidote."

A Report on the Dangers of Penetrating Radiations and the Methods of Avoiding Them. *A. Broca.* Abstracted as follows from Jour. de radiol. et d'électrol., 1921, Vol. 5, 414, in Med. Science, Feb., 1922, 5, No. 5, 451-452.—"The author begins by giving an account of emanation in which he states that it is only dangerous when confined, and especially so to those charging the tubes; those who apply either radium or its emanation to patients do not come under the direct action of its rays because of the screens. He considers the question of the effect on the atmosphere and concludes that good ventilation will avert all danger. He puts forward the hypothesis that possibly the minute trace of emanation often observable in the air is useful to life or even indispensable and says that institutes of radium should not be classed as unhealthy institutions with the quantities at present in existence.

"*Dangers of Penetrating Radiations for the Manipulators—Methods of Protection.*—An account of the various lesions caused by X-rays and radium is given, and the author states that in institutes of radium, lesions analogous to the chronic lesions caused by X-rays are seen; leucopenia especially is mentioned. To combat this the personnel at the Radium Institute of Paris have their blood examined periodically and are given the holidays necessary to maintain the blood in order; these precautions have been found to be sufficient. In brief, the points to be observed are: (1) only handle a radio-active tube with forceps, taking advantage of the falling off of the radiation according to the square of the distance; (2) to protect deep organs from effects at a remote date use lead screens.

"*Protection of Medical Personnel and their Surroundings.*—The author states that every X-ray bulb should have an absorbent cover and every beam of rays should be as small as possible. These devices will not always be sufficient when using penetrating rays over a long period, and here advantage of the square of the distance law can be taken."

"*Conclusions.*—The younger radiologists who take the precautions mentioned above are not affected by chronic radiodermatitis or by leucocytic disorders. At present a radiological installation is not prejudicial to the neighbourhood. In conclusion the author states that those who make radiology their work are much the same as those medical men who are daily exposed to infectious diseases; the dangers in the two cases are of the same order of probability."

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Industrial Tuberculosis. *F. Humbert.* Internat. Jour. Pub. Health, Nov.-Dec., 1921, 11, No. 6, 621-630. The main part of this paper consists of tables derived from a study made by the Prudential Insurance Company of New York on the basis of their experience in the years from 1907 to 1912. The percentage of deaths from tuberculosis in unhealthy trades (28 trades included) is given. The statistics are said to "confirm in a

large measure findings which are now classical," but to show also some variation.

Tuberculosis of the lungs, other forms of tuberculosis and other respiratory diseases causing death are recorded for three age groups (15 to 24, 25 to 44, 45 and over) for the different occupations of the list. The occupations have been grouped also in regard to the essential hazard involved, and the percentage of deaths (in proportion to all diseases) is given for the different age groups and the types of respiratory disease for each occupational group.

It is shown that different places are taken by the same occupation according to the age, and it is also pointed out that the relative danger of tuberculosis can only be determined for any given trade by giving the tuberculosis death rate in it as a percentage of the total death rate. "This method of comparison acquits tuberculosis of various unjust accusations." The high tuberculosis mortality in certain trades corresponds with a higher general mortality.

Greenwood maintains that analysis of statistics on these points should take account of: (*a*) industrial selection—type of physique chosen by the occupation, the age at which workers enter, etc.; (*b*) industrial status; (*c*) the industrial environment. To quote from Collis and Greenwood: "The rôle of the factory is, by confinement in monotonously ventilated rooms and by causing general fatigue, to reduce the resistance of the operative to those sources of infection to which he is exposed in the natural course of life."

It is the theory of Collis and Greenwood that the industrial environment, whatever it may be, is one cause of "tuberculization;" and this theory was borne out by experiences in industry during the War. "The proportion of tuberculosis deaths, as compared with the total mortality increased from 35 per cent. to 42 per cent. in the industrial regions, but not in the others."

Tebb conducted an inquiry in some munitions factories and showed that tuberculosis (as measured by officially reported cases) was five times as frequent in the group of factories in which building construction and hygienic conditions were poor, as compared with "large modern factories, well constructed and managed in conformity with the requirements of hygiene."

Bräuning has published figures about tuberculosis among hospital nurses. The general tuberculosis morbidity in this class is 60 per 10,000, as compared with 63 per 10,000 among insured people in all occupations. But a careful study of cases shows "a marked preponderance of infection amongst women who were formerly healthy and who have had charge of cases of tuberculosis."

Maes has studied the effects of a secluded and ascetic life as explaining the predominance of tuberculosis in a Catholic congregation. But Hamel's results are in partial contradiction with the findings of Maes.

Tuberculosis morbidity and mortality statistics should be compiled on a uniform plan and should not be used without consulting both the general mortality rate and the incidence of tuberculosis relative to other industries. The influence of industrial life on tuberculosis morbidity might be reduced by the application of general measures of hygiene not specially directed against tuberculosis.

"Special surveys should be carried out for each separate occupation in order to disclose the ultimate avoidable causes of contagion and to stimulate scientific prophylaxis."—G. E. Partridge.

Disinfecting Skins and Hair for Anthrax. *Henry Field Smyth.* Am. Jour. Hyg., Sept.-Nov., 1921, 1, Nos. 5-6, 541-556.—"This paper gives details of several series of tests carried out by the author on the disinfection of skins and horse hair for anthrax.

"In these tests five strains of anthrax bacilli were employed, an old laboratory stock strain, three strains isolated from tannery soak vats and one strain isolated from horse hair.

"Especially resistant spores were obtained by preliminary growth on wheat agar.

"Rejuvenation of spores damaged by treatment, but not killed, was encouraged by subculture in dextrose-serum-bouillon.

"In testing action on skins the most satisfactory method of preparing samples was found to be intradermal inoculation of

soaked squares of skin with saline suspensions of anthrax spores.

"The lime soak of 5 per cent. CaO permitted by the Bureau of Animal Industry regulations proved to be unreliable, even after a 72-hour exposure.

"The Schattenfroh method of soaking skins in 2 per cent. HCl and 10 per cent. NaCl solution for 48 hours at room temperature gave uniformly good results if carried out under conditions similar to those employed in the tannery, and produced skins that could be made into satisfactory leather.

"Anthrax infested horse hair can be satisfactorily disinfected by several methods:

"(a) By steam under pressure in the autoclave (15 lbs.) for 30 minutes.

"(b) By dry heat—200° F. for 24 hours (but not 200° F. for 15 min. as permitted by the Bureau of Animal Industry).

"(c) By formaldehyde as used in England.

"Cyllin disinfectant in the strength and under the conditions certified in England will not kill anthrax spores."

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Eye Conservation in Industry. Eyesight Conservation Bull., No. 1, 1922, pp. 29. —This pamphlet, published by the Eye Sight Conservation Council of America, presents one important phase of the study of "Waste in Industry" as conducted under the auspices of the Federated American Engineering Societies—namely, the chapter on conservation of vision. The subject is treated under three headings: hazards, vision, and illumination.

Hazards.—The effectiveness of protective methods is discussed, and reports from several large industries are included as proof of the advantages of goggles. A list of the processes or operations in which protection to the eyes is necessary is quoted from the "National Code for the Protection of the Heads and Eyes of Industrial Workers," and the requirements and standards for goggles, methods of overcoming objections to goggles, and the treatment of unavoidable accidents are given brief consideration.

Vision.—"That correction of sub-standard vision produces an increase in return that will pay for its cost—though no set of figures at hand will place this return on a dependable monetary basis—is the conclusion of the management in plants where several years of trial have provided a basis for judgment." As examples, the experiences of the Hood Rubber Company, of the Cheney Silk Company, and of Sears-Roebuck and Company are cited.

Figures are given showing the frequency of sub-standard vision, and emphasis is placed on the necessity of visual acuity standards which will give the necessary minimum for each kind of work.

Illumination.—Although the value of good lighting has been recognized for some time, it has not been sufficiently appreciated, on a monetary basis, to enforce its general adoption. This is shown in a tabulated report of the lighting conditions found in 446 plants investigated.

The requirements for efficient lighting are stated briefly, and the merits of different lighting systems are compared. "The cost for providing adequate illumination for the entire industry of the country would amount to one-half per cent. to one per cent. of wages. The cost per capita of correcting vision, instituting and carrying out measures of protection against hazards and bringing the lighting up to good standards, is definitely greater in the small plant than in the larger organizations—those employing two thousand workers or more—and the small plants are in the large majority. These smaller plants are therefore less ready to take up any of these measures unless the early returns of a dividend can be clearly shown. Reports of more study, the example of the earlier ones to take the steps, must be brought before them constantly so that efforts to check preventable loss along these lines may become more nearly universal."

A copy of this bulletin may be secured by forwarding 25 cents in stamps to the Eye Sight Conservation Council of America, Times Building, New York City

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

The Promotion of Accident Prevention. Part II. *Schoeneich.* Zentralbl. f. Gewerbehyg., Sept., 1921, 9, No. 9, 207-211.—Injuries with disability lasting over fourteen weeks are due more to the dangers of daily life and work than to the special occupational risks. The increasing toll of accidents, in spite of laws and mechanical devices, can be met only by getting co-operation in preventive work among all the workers. The function of the school is discussed at length in this regard.—E. L. Sevringhaus.

Inseparable Safety Devices. *Hans Hederich.* Zentralbl. f. Gewerbehyg., Nov., 1921, 9, No. 11, 271-274.—Diagrams are shown of several safety devices which are designed to make the different types of presses, to which they are attached, inoperable if they are detached or are not used.—E. L. Sevringhaus.

A Fatal Accident from Welding a Benzine Container. *Morgner.* Zentralbl. f. Gewerbehyg., Sept., 1921, 9, No. 9, 211-212.—A metallic benzine container was sent in for repair of a leak. Welding with the acetylene flame caused an explosion with fatal result to the operator because the vapors of the benzine had not been completely removed from the tank. Difficulty in removing vapors of hydrocarbons is pointed out, and the methods recommended are discussed.—E. L. Sevringhaus.

Firefoam Protection of Extra-Hazardous Risks in Manufactories. *D. M. Patterson.* Abstracted as follows from Chem. and Metall. Engin., 1921, Vol. 25, 887-888, by W. H. Boynton, in Chem. Abstr., Jan. 20, 1922, 16, No. 2, 304.—"In the dye-making, paint and varnish industries water has little value as protection against fire. An automatic Firefoam sprinkler system is effective. The system requires two solution tanks and two separate piping systems, one pipe to deliver $Al_2(SO_4)_3$ solution and the other $NaHCO_3$ solution containing Foamite. The foam produced upon contact of these two solutions has a volume eight times their combined volumes. Mixture is effected at the sprinkler head. The tank storing the acid solution must be of wood of special construction or of Pb-lined steel. The dry pipe system and ordinary piping are generally used to eliminate the necessity of Pb-lined pipe throughout and the system must be washed out with water after use. The valveless system used for small installations is illustrated. The solution tanks are filled 2/3 full of the solutions and air pressure built up to the pressure required to deliver the solutions to the heads. The same pressure is built up in the pipe lines through the check valves; these have a small orifice through them which compensates for minor leaks in the air pipes, but is too small to compensate when a sprinkler head is released. The result of this unbalanced pressure in the solution tanks starts the sprinklers."

Safety in the California Petroleum Industry. *Roy W. Kelly.* Nat. Safety News, Jan., 1922, 5, No. 1, 13.—Owing to the fact that the majority of employees engaged in the oil industry are native-born or of native-born parentage, the problem of organized safety work is very simple.

The Associated Oil Company, which has a typical safety program, has a safety organization headed by a safety board consisting of: the general superintendent of producing fields, the manager of manufacturing, the chief engineer, the manager of the tax and claim department, and the manager of the industrial relations department. Local safety committees exist, both in producing fields and in the refineries, of representatives of workmen and of foremen.

The functions of the safety board are supervisory and executive. It originates plans and passes upon suggestions made by local committees. It secures data upon which to base its safety campaigns. In each of the eight large divisions of the company, the industrial relations department has an employment foreman who is responsible for the following matters: employment, inspection of housing and sanitation, investigation of grievances, safety, etc.

Records show the causes and number of accidents. Of these, the majority are due

to carelessness, inattention, or the wrong method of doing the work. In order to decrease the number of accidents, educational channels have been opened through mass meetings with lectures and motion pictures, bulletin boards with accompanying photographs, the establishment of a small library, and a "No Accident Week."—M. C. Hamblet.

Cement Plant Accidents Cut 75 Per Cent. in 1921 Safety Drives. *H. G. Jacobson.* Nat. Safety News, Feb., 1922, 5, No. 2, 21.—"During the past year the Bureau of Accident Prevention and Insurance of the Portland Cement Association has conducted safety campaigns at a number of its plants in the form of no-accident months. The purpose of these campaigns was to prove that, taking the plants in their present generally well guarded condition, about 75 per cent. of the accidents can be prevented by application of more efficient methods for selling the proposition to the men.

"Thirty-nine plants during various months of the year conducted these no-accident month campaigns with the result that, in comparison with the corresponding month of the previous year with approximately the same number of men employed during these months:

"The number of accidents was reduced from 155 to 45, or 70.9 per cent;

"Days lost were reduced from 2,205 to 504, or 77.1 per cent.;

"Deaths were reduced from 4 to 1, or 75 per cent."—M. C. Hamblet.

INDUSTRIAL SURGERY

Underground Dressing Stations. *R. R. Sayers.* Hosp. Management, Jan., 1922, 13, No. 1, 60, 62.—The construction, location and equipment of first-aid rooms in mines are dealt with in this article. A first-aid dressing station should be built with the possibility in mind of its being used as a refuge chamber, with doors and stoppings gas proof. It is sometimes possible to locate a station under a diamond drill hole or core drill hole extending to the surface. This will help to ventilate the chamber, serve as conduit for telephone and electric wires, and if the station is used as a refuge after a disaster, food and water can be lowered to the trapped miners through it.

The minimum equipment required in government leased mines is given. First-aid material should be kept in tight containers. In addition, a well-equipped first-aid cabinet, a woolen blanket, a water-proof blanket, a set of splints and a stretcher should be kept convenient to the live workings in each section of the mine.

Objections concerning the stealing and abuse of first-aid materials, the tendency to take an injured man to the station before caring for his injury in any way, and the fact that men having minor injuries dressed at the station feel that it is unnecessary to be treated by a physician, are answered.

Medical and Medical-Defense Aspects of Fractures. *J. E. Tuckerman.* Ohio State Med. Jour., Nov. 1, 1921, 17, No. 11, 735.—Up to May, 1921, in forty instances out of 107 matters referred to the Ohio Medical Defense Committee, dissatisfaction arose from fractures. Fractures cause upwards of one-half the suits against physicians, and this accords with the experience of medical defense committees in other states. The keeping of case records is therefore important.

The various complications arising from fracture are commented on: the tendency of charity patients and those misrepresenting their economic status to be induced to enter suit more frequently than others; the physical condition of patients and complicating diseases; complicating infections; pain; and concealed fractures. The value of the radiograph record taken before and after setting, the limitations of the radiograph record, and the restoration of function are also discussed.—G. E. Partridge.

Fractured Femurs. *C. E. Early.* Calif. State Jour. Med., Dec., 1921, 19, No. 12, 474-477. The author concludes with the following summary:

"1. Fracture of the femur is a serious process, both in its immediate aspect and its

possibility of permanent impairment of the artisan's function.

"2. The Whitman and Thomas splint methods bring almost perfect results if properly applied. The medical profession was slow to take them up but the great war, and later experiences in industrial surgery, proved their efficiency.

"3. Every case should be painstakingly watched. Daily inspection and frequent X-ray examinations are as essential as the proper application of the method chosen for treatment.

"4. The mobility of the knee should be carefully guarded both by free, passive, and active movements and massage.

"I have purposely not entered into the discussion of compounded fractures of this bone, because the essentials of treatment are the same as in uncomplicated cases, save for the proper management of the soft parts and any ensuing infection. This would open up the field of the treatment of wounds and infections and would really not in any way be tantamount to the essential process considered here—the treatment of fractured femurs."—M. C. Shorley.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Second Annual Report of the Industrial Fatigue Research Board to September 30, 1921. H. M. Stationery Office, London, 1922, pp. 65.—This report on the work accomplished by the Industrial Fatigue Research Board is one of unusual interest since it contains an admirable analysis which sets forth how the facts established in the various reports which have been issued fit into the whole study of human activity.

The report first details the means of measurement used in the different investigations—output, labor turnover, sickness and mortality, lost-time and accidents—and then proceeds to narrate how they have been applied in many industries, such as the manufacture of munitions of war; boot making; textile spinning and weaving; the manufacture of iron, steel, and tinplates; metal polishing; and foundry work.

This report shows how coherent has been the work, and how immense advances have been made in this new science, the study of the human factor in industry. Regularity of output from hour to hour, from spell to spell, and from day to day, is found to mark high efficiency and sound physiological environment; this follows from the conclusion that output is controlled by two opposing factors: (*a*) increased efficiency due to practice, which causes a rise in output; and (*b*) fatigue effects, which accumulate during the course of the spell, of the day, or of the week, and tend to bring about a gradual fall in output. Whatever postpones fatigue effects permits full play of efficiency due to practice. Rest-pauses, organized to suit different processes, are found useful to this end. Attention to the personal rhythm of the workers produces important results. Ventilation planned on physiological lines is shown to be of great value and to be practicable. Optimum temperatures for different classes of work are established. The influence of illumination is displayed. The effects of reducing and of lengthening hours of work have been fully prospected. The influence of the human and of the mechanical factors on work are established. Vocational selection and motion study have received attention; and in relation to the latter the new work referred to promises to revolutionize previous methods and ideas.

Throughout the report appeal is made to statistics and to excellent diagrams in support of the conclusions arrived at. The whole is, however, so condensed that no adequate summary can be presented. The document is indeed quite different from ordinary reports, and resembles rather a well and carefully written textbook, to which everyone interested in the subject of industrial hygiene must turn for information and advice.

The machinery and organization for carrying on the research during the year underwent reconstruction, necessitated by the stern need for economy. Opportunity was at the same time taken to widen the terms

of reference to the Board, so that in future the scope of activities may cover all sides of human industrial activity.—E. L. Collis.

Industrial Fatigue in Chemical Works. *E. F. Armstrong.* Jour. Soc. Chem. Indust., Jan. 16, 1922, 41, No. 1, 2-3R.—A brief general article to the effect that labor in chemical plants is confronted with work requiring a greater degree of intelligence and of a less monotonous type than the ordinary piecework met with in general manufacturing. Shorter hours of labor and the general disinclination of the worker to exert himself make the problem of industrial fatigue of minor importance.—Philip Drinker.

The Problem of Industrial Fatigue in India. *Gladys M. Broughton.* Jour. Indian Indust. and Labour, Nov., 1921, Vol. 1, Part 4.—This article is a good summary of the work which has been done in England. Interest is attached to its appearance in India and to an appeal which the author makes for similar work to be undertaken in that country. She asks for records to be kept of output, sickness, labor turnover, and accidents for purposes of subsequent scientific analysis and study. India presents its own problems; industrialism is young; there is no hereditary industrial class and labor is almost entirely recruited from the ranks of agricultural workers. Hence, unique opportunities exist for watching and investigating the effect of industrial development, and for guiding it, as it has not been guided elsewhere, from small beginnings on hygienic lines.—E. L. Collis.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

The Report of the Committee (British) on Smoke and Noxious Vapours Abatement. *J. B. Cohen.* Jour. Soc. Chem. Indust., Jan. 16, 1922, 41, No. 1, 1-2R.—A review of the report of the above committee.—Philip Drinker.

Second Report of the Departmental (Home Office) Committee on Lighting in Factories and Workshops. Illuminating Engineer, Oct., 1921, 14, No. 8, 192.—This committee was appointed in 1913, issued its first report in 1915, and resumed work after the war in 1920. The second report which has now been issued deals chiefly with: (1) glare; (2) shadow; (3) constancy. In the first report glare was defined as resulting from: (1) the effect of looking directly at a bright source of light; (2) the annoyance caused by the presence of a bright source of light towards the edge of the field of vision; (3) the result of looking at polished surfaces. The first essential is the proper shading of the light sources, and in this connection the committee makes the following recommendations:

1. *Glare.* "(A) . . . Every light source (except one of low brightness) within a distance of 100 feet from any person employed shall be so shaded from such person that no part of the filament, mantle or flame is distinguishable through the shade, unless it be so placed that the angle between the line from the eye to an unshaded part of a source and a horizontal plane is not less than 20 degrees, or in the case of any person employed at a distance of 6 feet or less from the source, not less than 30 degrees."

"(B) . . . . Adequate means shall be taken, either by suitable placing or screening of the light sources, or by some other effective method, to prevent direct reflection of the light from a smooth or polished surface into the eyes of the worker."

2. *Shadow.*—"(C) . . . . . Adequate means shall be taken to prevent the formation of shadows which interfere with the safety or efficiency of any person employed."

3. *Constancy.*—"(D) . . . . No light sources which flicker or undergo abrupt changes in candlepower in such a manner as to interfere with the safety or efficiency of any person employed shall be used for the illumination of a factory or workshop."

"(E) . . . . That as regards existing installations a reasonable time limit should be given before the above requirements become operative."—T. L. Llewellyn.

Industrial Lighting. Some Notes on the Annual Report of H. M. Chief Inspector of Factories for 1920. Illuminating Engineer, Nov., 1921, 14, No. 9, 213.—Attention is called to the Welfare Pamphlet No. 7 on "Lighting in Factories and Workshops." One of the worst features is the neglect of natural lighting; broken panes are not repaired but are stuffed with rags, windows are allowed to become covered with dust or obscured with paint. Thick dulled glass reduces illumination, is difficult to keep clean and gives a dreary lighting effect.

In a sub-report on arc welding, Dr. Bridge gives an account of the inflammation which results from an exposure lasting only a few seconds. Dr. Bridge has not found permanent injury resulting, but cases of keratitis have been reported by other observers. The inflammation usually begins four hours after exposure and subsides within twenty-four to forty-eight hours.

Sir J. H. Parsons gives a summary of the report of the Glassworkers' Cataract Committee. Although repeated and prolonged exposure to ultraviolet rays produces changes in the lens, the conclusion of the committee is that the active agent in inducing the cataract among glassworkers is exposure to heat energy. With the use of the proper type of "Crookes" glass the disease would be abolished.—T. L. Llewellyn.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

New York State Miscellaneous Labor Laws with Amendments, Additions and Annotations to November 1, 1921. N. Y. State Dept. Labor, Indust. Commission, 1921, pp. 163.—"This pamphlet embraces provisions of the laws of New York which directly or indirectly affect labor, other than the Labor Law and the Workmen's Compensation Law. The text is taken, for the most part, from the Consolidated Laws of 1909 with amendments up to and including the year 1921. Some provisions are taken from the Civil Practice Act and from the Code of Criminal Procedure. A few are special or local acts. Specific reference is given in all cases to amendments."—M. Dent.

Methods of Adjustment in Industrial Disputes in Germany. Internat. Labour Rev., Jan., 1922, 5, No. 1, 51-65.—A detailed history of legislation and the work of courts and boards governing industrial relations is given. The agencies of adjustment are of two kinds, those set up by law, and those created by collective agreement. The statutory authorities for the adjustment of disputes include the ordinary and special adjustment boards, the Demobilization Commissioners and the industrial and commercial courts, the guild boards, and seamen's boards. The organization and the procedure of these boards is given.

In 1919 there were, in Germany, 264 local adjustment boards. The total number of disputes brought before them was 84,846, somewhat more than half being individual disputes, a type that was intended to go before these boards only until the labor courts were set up. Of the total number of disputes, conciliation was successful in 35 per cent.; arbitration in 36 per cent.; and simple mediation without oral proceedings in 28 per cent.

Figures are given also for the disputes taken over by the Federal Ministry of Labor for settlement.

A new Labor Disputes Code was submitted to the Federal Economic Council in November, 1920, and approved in December, 1921.—G. E. Partridge.

Draft Conventions. Internat. Labour Office, Official Bull., Nov. 23, 1921, 4, No. 21, 446-447.—In Bulgaria the duration of work is now regulated by the Decree of 1919. This goes beyond the Draft Convention, in including commercial enterprises. The Draft Convention admits exceptions, but, on the other hand, it offers advantages for the application of the eight-hour day to every class of industry. The operation of the Draft Convention will be delayed in Bulgaria probably until July, 1924.

In regard to night work of women and young persons, the present Bulgarian law is

much more comprehensive than the two Draft Conventions. Section 18 applies both to commercial and transport occupations and allows no exceptions in the case of persons from 16 to 18 years. The exceptions provided in regard to the night work of women are more appropriate than those of the Draft Convention. Exceptions are made in the case of work especially suitable for women, and exceptions are allowed for women after 5 A. M. or 6 A. M. and after 8 or 9 P. M. in such a way as to allow for two shifts daily.

Bulgarian legislation has been directed toward forming a system of legal protection of women during pregnancy. By the terms of the law already in force, women are entitled to a period of eight weeks' rest before and after confinement (one to four weeks before and one to four weeks after). The working mother receives half the amount of her wages. The nursing mother is entitled to two hours' absence from work on Saturdays for a period of six months without wage reduction. The Insurance Act has modified this, and the woman receives a benefit from the workers' insurance fund. There will be no difficulty in ratifying the Convention, since the differences between this and the law now in force are slight.—G. E. Partridge.

Unemployment Compensation an Aid to Economic Security. *Seebohm Rowntree*. Am. Labor Legis. Rev., Dec., 1921, 11, No. 4, 295-298.—The menace of unemployment is a serious evil, and it is the duty of the community to take every step to steady the labor market and to provide work for the unemployed. But when all has been done there still remains a margin of unemployed which probably amounts, in a series of years, to about 5 per cent. Industry should make some adequate provision for this margin when it cannot be absorbed. Industry should pay enough to prevent serious privation for the involuntarily unemployed, and thus remove from workers the practical menace of their liability to unemployment. Unemployment insurance can be organized either by the state, or by individual factories or groups of factories. It is probably desirable that the worker should bear a share of the loss from unemployment, and also that the community as a whole should contribute, as is provided in Britain by the National Unemployment Insurance Act. "The fear of unemployment and the sense of injustice associated with this fear in the minds of the workers are two of the most potent causes of labor unrest, and a measure which would remove them would have a unique effect in dispelling that unrest."—G. E. Partridge.

Industrial Accident Insurance. Am. Labor Legis. Rev., Dec., 1921, 11, No. 4, 351-368. —This is a summary of state legislation in the United States in 1921, relating to employers' liability and workmen's compensation (including under the latter new acts, acts supplementary to existing laws and vocational rehabilitation).

Two states — Oregon and Texas — have passed acts concerning employers' liability. Missouri has passed a new workmen's compensation act to take the place of one repealed by referendum. About half the states have passed supplementary acts during the year, and about as many have passed some act in regard to vocational rehabilitation. New Hampshire has provided for an unpaid commission to investigate and make recommendations for improving employers' liability and workmen's compensation laws, and North Carolina has made a small appropriation for a similar commission. There is a federal act providing additional hospital and dispensary facilities for the treatment of war cases under the bureau of war risk insurance.—G. E. Partridge.

Industrial Insurance, Medical Aid and Safety Acts. Washington State Dept. of Labor and Industries, Olympia, Wash., 1921, pp. 158.—This pamphlet sets forth the laws of the state of Washington, enacted and amended to 1921, covering industrial insurance, medical aid in industry, safety acts applying to those establishments under the jurisdiction of the Industrial Insurance Department, together with the administrative code, rules for electrical construction, and inspection of public utilities, and laws relating to the education and marketing of the industrial products of the adult blind.—M. Dent.

REHABILITATION OF DISABLED EMPLOYEES

ON BEHALF OF THE INDUSTRIAL DISABLED. *Gerald A. Boate.* Indust. Management, Dec., 1921, 62, No. 6, 345-352.—Industrial training and technical education have received world wide attention during the past four years, and "the disabled ex-service man has spread the gospel of vocational education into the most remote corners of America." The need is now for a clearing house of information, and for "standard practice instructions," drawn up by competent observers.

How may a disabled person be fitted for a position in industry or commerce which will be free from working conditions that will aggravate the disability, and so that he may work with others who are not handicapped? The answer is, by adequate training. The period of training will vary with the occupation, but usually it will not exceed eighteen months for grades below professional. This training must be so well given that the school can demand a market for its product, and the candidate need not apologize for having passed through a vocational school.

In the analysis of occupations for the reabsorption of the disabled, the equipment, the content of courses, the work produced and the working conditions in the school, "it is well to work back from industry, making the atmosphere of the school and its shops as nearly like the factory as possible. Firmness and justice and a square deal are much more appreciated than kindness, sympathy and laxity." A minimum course should be carefully analyzed out, records should be kept of everyone under training, results charted and desirable standards of achievements set up. The object is to complete training for an industry. Only when the man becomes competent and enters a vocation where progress is satisfactory to all concerned should oversight be relaxed, and only then should the employer be expected to pay the full wage to the re-trained disabled man. Even after this there should still be follow-up work by those fitted to become judges or arbitrators.

A list of 314 occupations is given, comprising occupations that have been chosen by disabled ex-soldiers and a sample of analysis of occupation is offered in the form of a diagram showing the usual organization of three types of pattern making and the grade of technical skill required in each department. A detailed analysis is worked out for some of the processes, and there is an outline for guidance in the scientific selecting of suitable occupations for disabled men.—G. E. Partridge.

CLINICAL EXPERIENCE AS TO THE SEVERAL KINDS OF PHYSIOTHERAPY EMPLOYED IN RECONSTRUCTION WORK. *James T. Watkins.* Calif. State Jour. Med., Dec., 1921, 19, No. 12, 471-474.—Dr. Watkins reviews briefly the value of the more generally employed physical therapeutic agents—namely, massage; manipulation; hydrotherapy; thermotherapy; electrotherapy; and mechanotherapy.—M. C. Shorley.

THE DEVELOPMENT OF A MODERN MEDICAL SERVICE FOR THE INDUSTRIAL INJURED AND SICK AT THE HAHNEMANN HOSPITAL OF THE UNIVERSITY OF CALIFORNIA. *Edgar L. Gilcreest.* Calif. State Jour. Med., Dec., 1921, 19, No. 12, 462-464.—The University of California in its industrial hospital, the Hahnemann Hospital, is attempting to furnish a complete service for the industrial injured. There are maintained departments of physiotherapy, occupational therapy, and social service.

Nine specially trained technicians treat daily about seventy cases in the physiotherapeutic department. Emphasis is laid upon the operation of trained attendants rather than upon the use of elaborate machines. All patients are treated under the supervision of a physician, and efforts are made to familiarize physicians, who send patients to physiotherapy, with the functions of the department by requiring that patients be treated only upon the prescription from the attending physician and that the attending physician see each case frequently in conference with the physiotherapy worker. The technicians should have attractive personalities, and should be sympathetic and encouraging. This functional re-education is best carried out in a clinic. The psychic effect upon the patient of receiving treatment together with others suffering from similar disabilities is excellent.

The occupational therapy department covers the function of bedside occupation and

light occupation for the average convalescent. Occupational therapy is of value to both the patient's mind and body, and is of great assistance to both the physician and the nurse. The difficulties encountered in occupational therapy are:

"1. The adult mind does not learn easily, especially after long years of mental inactivity.

"2. Getting started with a patient is in many cases a slow process, requiring much tact and patience.

"3. It is not easy for him to realize the therapeutic value of work.

"4. The ambitionless type is difficult to stimulate."

The social service department performs one of the most important phases of industrial rehabilitation, namely, that of aiding the disabled workman to believe in himself and in his own ability to become industrially independent again.

An outpatient department is maintained especially for the benefit of men who have been convalescing in the hospital for a long time and are still in need of physiotherapy. These men are placed in supervised homes nearby as soon as it is safe for them to leave the hospital, but they return to the hospital for meals. In this way they are kept in a healthful atmosphere and yet do not become hospitalized or dependent.—M. C. Shorley.

Return to Work after Injury. *Morton R. Gibbons.* Calif. State Jour. Med., Dec., 1921, 19, No. 12, 458-459.—It is Dr. Gibbons' opinion that treatment of the injured should involve as slight departure from normal in habits and environment as is compatible with proper technical treatment. He believes that no one is normally entitled to idleness because he has been hurt, but that every injured person is morally entitled to earn whatever he can with whatever function he possesses. Work-treatment after injury can be ideally carried on in a large industrial plant which maintains its own dispensary and medical department. The surgeon can make inspection of the work environment of the injured under his treatment and, being familiar with the situation, can prescribe work and see that it is carried out without abuse. The vast numbers of persons injured in small plants are not so easily disposed of, however. In such cases, the insurance companies could, by a system of merit rating, or some similar system, arrange for work for the convalescent in the plants in which they were injured. The alternative for this is workshops connected with hospitals—an arrangement which presents many difficulties, among them the disposal of the product, if the injured man is to be paid for his work.

The points which Dr. Gibbons emphasizes in particular are:

"That injury is not to entail idleness.

"Work is to be provided with full pay.

"Work in the plant where injured, under supervision of the plant physician, is good.

"Work provided by hospital, school, farm, etc., is preferable to idleness.

"Pay must be the same as when injured." —M. C. Shorley.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

VOLUME IV | JULY, 1922 | NUMBER 3

CONTENTS

GENERAL

PROBLEMS OF INDUSTRIAL HYGIENE IN RELATION TO PUBLIC HEALTH. *Thomas Oliver.* —This paper, a lecture delivered in the Royal Institute of Public Health, states that problems of industrial hygiene, which first received serious attention in Great Britain, achieved less than the anticipated results, owing to lack of organization. The following points are emphasized by Dr. Oliver:

1. Industrial medicine must be both preventive and curative.
2. Vocational guidance is essential.
3. Men resuming work, after an absence due to accident or illness, should be given either light employment or shorter hours.
4. "The essence of life is work," and appropriate employment ought to be provided for the partially fit as well as for the fully fit; for women as well as for men.
5. Woman's arena of usefulness is the home, and her sphere of influence the family; yet it is necessary to safeguard the married woman who earns her living, and especially the expectant mother.

Professor Oliver also draws attention to the great advantage of the Safety Bonus System, by which a foreman receives a substantial bonus if the frequency of accidents is reduced below a certain standard — the bonus to increase in inverse proportion to the number of accidents. He does not, however, point to the practical danger of so-called trivial accidents not being reported. More working hours are unnecessarily wasted by trivial accidents than from any other cause—*e.g.*, the cut finger becoming septic on account of neglect. To make this scheme effective a severe penalty should be inflicted

for failure to report accidents. Unfortunately, however, it is difficult to compel compliance with the rule of notification or to enforce a penalty for its infringement. This contention is borne out by Dr. Oliver's admission that "the severity rates were slightly higher in the bonus factories than in the non-bonus factories."—D. A. Coles.

Factory Inspection in Austria in 1919. Internat. Labour Rev., Jan., 1922, 5, No. 1, 151-157.—It is reported that factory inspection work in Austria was exceptionally heavy in 1919, on account of retrogression during the War. There was a decrease in the number of accidents reported during the year, and cases of occupational diseases were fewer than usual. Some of the difficulties met in making changes to the eight-hour plan and also in returning to required standards after the lax practices during the War are mentioned. A point of general interest is the recommendation made by the chief inspector condemning the general practice of referring accidents without inquiry to the worker's own fault in cases where injury might have been averted by certain precautions, since fatigue may render a worker incapable of proper care, and in such a case he cannot be held negligent.—G. E. Partridge.

Factory Inspection in Belgium. Internat. Labour Rev., Jan., 1922, 5, No. 1, 157-162.—In Belgium the factory inspection staff was twice as large in 1920 as during the pre-war period. Many small workshops were brought under inspection in 1919, as the act relating to the employment of women and children covered their employment everywhere except in family undertakings not regarded as dangerous to life or limb. Attempts to enforce labor laws have been impeded by the conditions brought on by the War, and the inspectors report that the War has practically blotted out the work of the last twenty years.—G. E. Partridge.

Labour Conditions in Japanese Coal Mines. Internat. Labour Rev., Feb., 1922, 5, No. 2, 251-264.—Coal miners form approximately 12 per cent. of the industrial population of Japan. The industry has developed rapidly since 1908, the number of workers employed in that year being 126,999 as compared with 348,240 in 1919.

The provisions governing working conditions, as laid down in the Regulations issued by the Department of Agriculture and Commerce in August, 1916, apply only to employees who are holders of permanent mining rights, and relate almost entirely to women and children. The employment of children under 12 years is forbidden, as is also the employment of women and of children under 15 years for more than twelve hours per day. No woman or child is allowed to work between the hours of 10 and 4 during the night, except on a shift, and then only provided the shift is changed periodically, the period not to exceed ten days. A thirty-minute rest period must be given to all women and children in a day longer than six hours, and a one-hour rest period in a day longer than ten hours. Two rest days per month are compulsory for women and children under 14 years, and four rest days per month when night shifts are worked.

Conditions of work for adult men are scarcely mentioned in the Regulations. Each miner is, however, required to submit for the approval of the chief of the Mining Board in his district such rules as he has adopted for the employment of workers in his mines. The condition of adult workers is, on the whole, better than might be inferred from this Regulation. The men are employed generally on two shifts of ten hours each per day, although some miners have introduced the eight-hour day with two or three shifts. Approximately the same rest periods are allowed as are provided for women and children.

Provisions are made for accident and sickness compensation, and each employer must draw up his own rules in accordance with these provisions and must then submit them for approval before commencing mining operations.

The Regulation concerning the Employment and Relief of Miners prohibits the employment of persons suffering from certain diseases likely to affect the health of other workers or likely to be aggravated by the

work on which they are engaged. It also contains provisions concerning the employment of women and children in unhealthy processes, and prohibits the employment of women within thirty-five days after childbirth, excepting in instances where the work is of a nature which the doctor pronounces to be harmless; and then the rule does not apply after twenty-one days.

The Japanese Bureau of Mines has been studying the provisions for sanitation in mines, the construction of workshops and dwelling houses in mining districts, the examination of drinking water, the analysis of the atmosphere in mines, and other such details, and plans to appoint a commission to introduce improvements and to lay down the provisions which the mine owners should adopt.

In all the larger mines, employers have established medical institutions for the benefit of their workers. In 1919, there were 171 mines throughout the country, each with its own medical bureau, and doctors in the ratio of one to 595 workers. In the mines with no such medical bureau, arrangements were made with the local doctor.—M. C. Shorley.

Prevention of Illness among Miners. *R. B. Sayers.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2319, Feb., 1922.—During the years 1920 and 1921 much work has been done on carbon monoxide. Forbes reports against occurrence of late after-symptoms from acute gassing (except in rare instances) unless there is a pre-existing pathological condition; he does not find cumulative harmful effects from frequent exposure. Experiments on animals do not show change in the coagulation time of the blood.

An investigation made by Henderson, Fieldner and Sayers (made especially to determine conditions for ventilation of the proposed New York-New Jersey tunnel) has given some new results. Several new methods have been developed, such as the iodine pentoxide method for the determination of carbon monoxide in air; collection and preservation of blood samples for carbon monoxide determination from persons overcome or affected by the gas; methods for the analysis of carbon monoxide in the blood. Henderson formulated a statement of the probable effects of different concentrations of the gas, as follows: When time of exposure in hours times the concentration of carbon monoxide in parts per 10,000 equals 3, there is no perceptible effect. When the result is 6 there is a just perceptible effect. When the result is 9, there will be headache and nausea. When the result is 15 or more, the effects are dangerous. The lack of poisonous effects of carbon monoxide on nerve tissue was demonstrated by exposing growing embryonic chick brain tissue to a high concentration of carbon monoxide. High temperature and high relative humidity have been shown to increase the rate of absorption of carbon monoxide by the blood owing to the increased frequency and rate of respiration, etc. In the treatment of carbon monoxide asphyxia, Henderson and Haggard advise the use of pure oxygen containing from 6 to 10 per cent. of carbon dioxide, but Sayers, O'Brien and Yant were unable to obtain such striking differences between the oxygen treatment and the carbon dioxide, and they decided that the method recommended was not suitable for use by first-aid men, but that oxygen should be available since the first few minutes after exposure to large quantities of carbon monoxide are the most important in the treatment. Lewin recommends bleeding in connection with use of oxygen, but American investigators advise against it. For the detection of carbon monoxide in air there are two comparatively recent methods which are described. A new gas mask is explained.

Some new findings in regard to carbon dioxide in air are reported; the conclusion being that, while it is possible to breathe 9 and 10 per cent. of carbon dioxide in oxygen, any percentage above 5 will cause noticeable effects, and between 2 and 2½ per cent. is all that should be permitted in the inspired air of an oxygen breathing apparatus at any time.

Prevention of miners' phthisis and tuberculosis is another subject on which there is new information. Orenstein and Ireland in South Africa have reached the following conclusions: (1) Dust is not alone the cause

of phthisis. (2) Ventilation does not increase the harmful dust conditions. (3) Exhausting air through the pipes from drives and winzes is much better than forcing air in through similar pipes. (4) Measurement of air currents and notes of any changes in velocity and direction in every section are absolutely necessary. (5) Air in stopes should be induced to flow along the face and not back in the open waste. (6) While eddies caused by local circulation may be helpful, such circulation can only be helpful for a limited time and as a temporary measure.

Ferguson concludes also that "the question of ventilation has more important bearing on the elimination of dust than has previously been recognized," and he recommends frequent examination of workers and elimination of those affected with silicosis. It is pointed out that both wet and dry drills may be dangerous. Warren has described a device for collecting the dust from drills, but states that "the real source of dust production is that caused by firing holes." He shows that promiscuous firing should never be permitted but a water blast that has a large air consumption is to be preferred, and should be used in the direction of ventilating currents. Harrington has emphasized the value of dust abatement by better ventilation.

Sayers and Harrington have studied the effects of high temperature and humidity in mines. It was found that, if the air temperature is above 75° F. and the relative humidity high, the efficiency and comfort of the worker are materially increased by air movement. An exhaustive study of the science of ventilation has been published by Hill. The U. S. Bureau of Mines, the U. S. Public Health Service, the American Society of Heating and Ventilating Engineers, the National Research Council and co-operating universities are now engaged in extensive laboratory studies to try to formulate definite standards of temperature, humidity, and air movement in order to maintain the health, efficiency, and comfort of workers. —G. E. Partridge.

The Third International Labour Conference: Commission on White Lead. Internat. Labour Rev., Feb., 1922, 5, No. 2, 193-195.—This report states briefly the work of the commission and the subcommissions which were appointed to investigate for the Third International Labour Conference the subject of the prohibition of the use of white lead in painting. The commission finally decided in favor of regulation, but by a very narrow majority. The majority recommended a Draft Convention; the minority formulated no definite decision, but contented themselves with a protestation in favor of prohibition.

"The Draft Convention finally adopted without opposition prohibits in a general way the use of white lead paints in interior work, but permits their use, under regulation, for outdoor operations. The superiority of white lead paints in the presence of fumes is apparently conceded since their use is permitted in the interior painting of railway stations and industrial establishments in which, in the opinion of the government delegates or experts, their use is necessary. Artistic painting and fine-lining are also excepted. On the other hand the employment, even in exterior work, of all women and of young persons under eighteen years of age is forbidden, except in the case of apprentices, for whom some elasticity is permissible in the interest of their trade education.

"A further Article of the Convention aims at securing statistics of morbidity and mortality in connection with lead poisoning among working painters. The Convention would become effective at the earliest in 1927.

"This Convention, like most legislation and most collective agreements, is a compromise, but if adopted it will represent a marked advance in industrial sanitary regulation, and, since its coming into operation is postponed for six years, there seems to be no reason why this advance should not be secured without serious disorganization of either the industry engaged in the production of the raw material or in that which utilizes the finished product. In any case, the human factor should stand first: the disadvantages of lead poisoning must be weighed against the evils of possible temporary unemployment in the lead paint industries."—M. C. Shorley.

DUST HAZARDS AND THEIR EFFECTS

On the Roentgen Picture of Pneumokoniosis, Especially in its Densest Form. *W. Jaensch.* Abstracted as follows from Fortschr. a. d. Geb. d. Röntgenstrahlen, 1921, Vol. 28, 299, in Med. Science, Feb., 1922, 5, No. 5, 455.—"The object of the writer of this article is to show the differentiation between pneumokoniosis and ordinary tuberculosis, for the clinical symptoms in both forms of disease resemble each other closely. One point of distinction he gives is that in pneumokoniosis it is seldom that the apex of the lung is affected, the disease mostly affecting the underlying parts of the upper lobe of the lung. It is, according to the Roentgen picture, more evenly distributed over both halves of the lungs than in advanced tuberculosis. Also dyspnoea may be marked in pneumokoniosis, whereas even in very advanced tuberculosis it is mostly absent. The tuberculin reaction is negative.

"According to the Roentgen photographic demonstrations, the shadow pictures differentiate between miliary tuberculosis and pneumokoniosis by the variation in the size of the shadow groups, leaving the apex almost free. Anthracosis and chalicosis reveal wider and more irregular patches.

"In a series of photographs the author shows the varied forms of lung patches caused by the different types of lung troubles, namely, syphilitic pneumonia, pneumokoniosis, etc., and lung affections caused by iron dust inhalations."

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Type and Environment of Employment as Factors in the Expectancy of Life of the Working Class Consumptive. *R. C. Wingfield.* Am. Rev. Tuberc., March, 1922, 6, No. 1, 69-73.—"If the standard we have taken is a fair one, these different groups, judged by it, show that the type and environment of a patient's work have but little influence on his expectancy of life. But tables 3 and 4 show that the careful choice of work does slightly increase his chance of survival by a small percentage; and the results of table 3 c. support this conclusion in a definite manner, and further lead us to think that a more detailed investigation in a larger number of cases, if properly interpreted, might even show a 10 per cent. increased expectancy of life.

"Finally, we should here call attention to table 3 b, which gives the worst result, indicating that an adult male, changing to physical work from nonphysical work, will probably be leaving skilled for unskilled work, which apart from anything else means a smaller wage. Further, there is the worry of learning and acquiring speed, that is, manual dexterity, which comes hard to any adult and harder still to a man past middle age. Worry is an important factor in tuberculosis, and may easily counterbalance the good effects of better working conditions."—M. C. Shorley.

Tuberculosis in Relation to Industry. *S. Lyle Cummins.* Jour. State Med., Jan., 1922, 30, No. 1, 4-14.—"If it is true that a large proportion of the tuberculosis mortality amongst male adults under industrial conditions is due rather to the awakening of old infections than to the inception of new disease through fresh infection, it is clear that this has a bearing on the employment of persons suffering from the disease in a chronic form consistent with fair health and average working capacity. If we were to take the view that such persons constitute a grave danger to their fellows under industrial conditions, we should be obliged, I think, as a nation, to face the question of their maintenance and to back up legislation for giving industrial grants to men withdrawn from their work in the interests of the community. Such legislation would be enormously costly, and would deprive many men of the privilege of fending for themselves while their physical condition permitted them to do so. My own view is that we must, with regard to the prevention of industrial tuberculosis, consider occupations as coming under two headings:

(1) Those in which infection plays a relatively small part; and (2) Those in which there is reason to think that it may play a very important part.

"In the first category I should place those industries where males are the chief employees and where there is no special element associated with the work which is calculated to facilitate infection.

"For practical purposes this category includes all our industries save those where there is danger of pneumoconiosis. In this category tuberculosis is, for practical purposes, an environmental rather than an infective disease. Our lines of prophylaxis should be directed to securing the best working and home conditions for those concerned, so that the stress of hardship, poverty, anxiety, and bad sanitation, in short, the bad physiological conditions so likely to lead to recrudescence of old infection, shall be lessened or avoided. In the second category I feel bound to place all occupations involving exposure to dangerous dusts. Here, although there is reason to think that the irritant particles frequently act by awakening old infections, there is also much evidence suggesting that re-infection, or fresh infection, is facilitated by the existence of silicosis. The example of South Africa is clearly a good one to follow, and the experience there leads the sanitary authorities to take every possible step to exclude infective cases from the mines. In this category, too, come, for a different reason, the young female industrial workers who quit domestic life shortly after adolescence to take up employment under factory and workshop conditions. The example of the female munition workers from 1917 to 1919 points clearly to the conclusion that here we have to deal with a group of people very little protected by acquired resistance, and, therefore, extremely liable to infection with the tubercle bacillus. Careful medical inspection and exclusion of infective cases is imperatively necessary in the interests of these women workers. Finally there is the question of the human beings who are most susceptible of all—the new arrivals in our industrial communities; children whose resistance is as yet very little developed. To my mind the urgent importance of legislation to exclude infective teachers from our schools is too often forgotten."—Barnett Cohen.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Making Gas—And Thinking Safety. *H. Blackburn Harte.* Nat. Safety News, Feb., 1922, 5, No. 2, 5-9.—The importance of getting their men to think safety in gas plants has been recognized by large corporations. The following are the safety measures which have been put into practice in The People's Gas Light and Coke Company of Chicago.

1. Most important of all is an "automatically timed controlling device which makes it impossible to open or close the gas generator valves in improper sequence, thus preventing explosions which might occur from so doing."

2. The installation of a heavy iron bar, one end of which is fastened in the steel floor and the other end of which is hooked onto the spokes of the hand wheel by which the valve gears are turned, has eliminated both the crushed hand and explosion hazards in the operation of the "hot valve" or "down-run valve" which is used for changing the direction of the flow of steam through the fire.

3. A system of fire apparatus—high pressure steam lines with hose connections—has been installed; also waterhose connections; large and small chemical extinguishers; water hand extinguishers; and fire alarm boxes.

4. Fire drills are held monthly.

5. The "No Smoking" rule is rigidly enforced.

6. A system of red and white lights informs the firemen of the amount of water in boilers.

7. The plant manufacturing benzol, toluol, and solvent naphtha is isolated.

8. Every employee must understand the prone pressure method of resuscitation and be qualified in administering it.

9. Building materials are fire-resisting; all glass is wire-glass; electric switches are located on the outside of the buildings and

are enclosed in boxes.

10. Life belts are used for men working in street vaults.

THE ELECTRIC FLASH LAMP AS A SAFETY DEVICE. *L. C. Ilsley.* Nat. Safety News, Feb., 1922, 5, No. 2, 37.—The electric flash lamp—on account of its low voltage, together with a certain measure of protection for the bulb, due to the battery case and bull's-eye lens—is one of the safest types of lamps commercially available for use in the vicinity of gasoline storage tanks, garages, or automobiles.

A method for increasing the degree of safety of flash lamps is suggested by the use of a safety device so designed as to project the bulb from the circuit, should the bulb glass be broken and the glowing filament bared.—M. C. Hamblet.

VENTILATION—A SAFETY FACTOR. *C. Lorimer Colburn.* Nat. Safety News, Feb., 1922, 5, No. 2, 36.—"A mine operator has not done everything in his power to make his mine safe if he has neglected to install a positive system of ventilation, for it is not safe to depend on atmospheric conditions for mine ventilation." The entire article is a plea for positive ventilation in mines.

HEAT, COLD AND HUMIDITY

THE INFLUENCE OF DRAFTS ON BODY TEMPERATURE. *B. Lange.* Abstracted from Ztschr. f. Hyg., Vol. 91, p. 473 in Hyg. Rundschau, Dec. 1, 1921, 31, No. 23, 705.—Experiments were made in a large closed room. The subjects sat 2 m. in front of an electrically driven ventilator. From minute to minute thermoelectric measurements of the skin temperature were taken from the forehead, neck, and chest, and recorded graphically.

Even in a calm the subjects differed according to age, development, and nutrition. The first cooling occurred equally quickly with cold and warm winds, but the recovery was slower after more intense and longer cooling. The velocity of the wind had an influence on the cooling. A velocity of 0.6 m. per second caused in five minutes a drop in the forehead temperature of 1.5 degrees, but a velocity of 3 to 6 m. per second only lowered it 3 to 4 degrees. Upon interruption of the wind the skin temperature rose at once. The lowest temperature obtained and the amount of difference between it and the temperature of the wind bore no relation to the feelings of the subjects, except that a prolonged draft was followed by a feeling of discomfort and cold in the parts usually covered by clothing. Several times rhinitis, sore throat, or bronchitis was observed. In the parts usually covered by clothes, the response to the stimulus of cold was slower than in the unclothed parts, owing to the difference in the vasoconstrictor muscles.

According to these experiments, drafts may cause bodily harm, because of the fact that the heat-regulatory mechanism of the body is not efficient for protection.—H. G. Noyes.

WOMEN AND CHILDREN IN INDUSTRY

MEDICAL ASPECT OF WOMEN'S ILLS IN INDUSTRY. *Clara P. Seippel.* U. S. Bur. Labor Statis., Month. Labor Rev., Nov., 1921, 13, No. 5, 945-950.—In 1910 eight million women in the United States were wage earners, and probably now about five million women and girls are working in shops and factories. Woman is a permanent factor in industry.

Statistics in regard to the ills of women in industry are largely wanting. There are some comparative figures about the relative occurrence of diseases among men and women, but little of value about women as women. Most figures also are based on absenteeism, while there is a great unaccounted loss from the ills of women who remain at work. Women appeal to the medical department of the shop most frequently because of headaches and dysmenorrhea. A large part of the minor ills can be traced to bad hygiene and irregular habits of life. Many girls go to work without breakfast. Many neglect to go to the toilet during the day, and so bring

on ill health; and this condition is due in part to the improper placing of toilet rooms, necessitating loss of time or embarrassment in going to them.

The monotony of women's work and natural fatigue predispose to illness, although, except for hazards, women in industry are not subject to disturbances not encountered elsewhere. But thousands of women accept unnecessary suffering habitually, especially in regard to menstrual functions, without ever understanding that it is avoidable. Often a simple cathartic for a few days before the period gives much relief. In general, there is need of employing nonsurgical methods as far as possible in correcting these ills. A very common condition is menorrhagia, very often neglected when perfectly amenable to treatment. Amenorrhea is also common, especially during the first year of industrial life, and the majority of cases respond to medical treatment.

Among older women there is also much unnecessary suffering. Very many think that the ills of the menopause are unavoidable. The hot flashes and other nervous disturbances which are so exhausting are, however, usually easily removed. Of married women in industry probably 75 per cent. have some form of pelvic disorder before the age of 40. Retroversion is common at all ages; often the only complaint is constant fatigue. The condition can be relieved, but if neglected becomes worse until surgical treatment is the only remedy. Retroversion is so common in young girls that it ought to be taken into consideration in industry. It is unwise for girls under 16 to work constantly at machines, and such work should in no case exceed two hours at a stretch.

Attention to simple matters of dress, ventilation, recreation, food, sleep, etc., would help greatly. "Our task is to educate the woman worker to take an interest in herself and to regard her health as the capital she has invested in the business from which she must draw her dividends of livelihood, happiness and contentment. That is the first step towards the conservation of woman power and the reduction of women's ills in industry."—G. E. Partridge.

The Joint Board of Sanitary Control in the New York Ladies' Garment Industries. Internat. Labour Rev., Jan., 1922, 5, No. 1, 125-129.—The Joint Board of Sanitary Control in the New York Ladies' Garment Industries was established in 1910. There are seven members: two nominees of the manufacturers, two of the trade unions, and three representing the general public.

The activities of the board are divided into four sections: sanitary, medical, fire-drill and educational. The educational aspect of the work has been emphasized and has been conducted by personal interviews, sanitary certificates, bulletins, journals, leaflets, through conferences, lectures, the press, exhibitions, and other means. The board is empowered to establish standards of sanitary conditions in the industry. There are shop committees giving special instruction in sanitation in a six-weeks' course.

Every half-year an inspection is made of the 3,866 workshops and the whole industry is then divided into four classes according to the defects found, and re-inspection varies in frequency accordingly. In connection with the system of inspection the board has established a nursing and first-aid service which installs and maintains first-aid equipment in each shop and instructs the workers in methods. Experts on light and ventilation are provided when needed. Certain of the local unions of the International Ladies' Garment Workers' Union own, manage, and finance a Union Health Center, and attention is given to preventive medicine; therapeutic clinics are also maintained. A number of the local unions have a tuberculosis benefit.

The result has been a complete change in the character of the industry.—G. E. Partridge.

The Employment of Children in the Weaving Industry in Persia. Internat. Labour Office, Official Bull., Dec. 21, 1921, 4, No. 25, 529-531.—Some time ago, the attention of the International Labour Office was drawn to the unsatisfactory conditions under which women and children are employed in Persia in certain carpet factories, especially in Kerman, and the matter was taken up with the Persian Ministry of Foreign Af-

fairs. As a result, the Persian government has taken steps to remedy the conditions of labor, and pending definite measures the Kerman local authorities have been requested to enforce the following articles:

"1. Engagement of workers to be effected with complete liberty on both sides.

"2. Eight-hour day.

"3. Prohibition of employment of boys and girls under age of ten years.

"4. Permission for workers to leave factory at midday for rest.

"5. Provision of healthy sites and pure air for factories.

"6. Preparation by local authorities of comfortable and suitable seats for women and children to allow work in normal positions, etc."—M. C. Shorley.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

VENTILATION AND EFFICIENCY IN FACTORIES. *Leonard Hill.* Lancet, Jan. 7, 1922, No. 5132, 56-60.—This lecture (a Chadwick Trust lecture) presents the modern view of the physiological action of ventilation. The importance to health of basal metabolism is stressed, and the necessity of exercise for increasing this metabolism is pointed out. On the other hand, the claim is made that sedentary occupation in still, warm atmospheres lowers the basal metabolism, slackens muscular tone, lessens appetite, causes constipation, makes shallow the breathing, and slows the circulation, rendering the worker feeble in health and liable to disease. Attention is drawn to the importance of respiration for cooling the body through the aqueous vapor exhaled. Efficiency is lowered by moist warm atmospheres; thus, a British student eats daily food of the value of some 4,000 calories, while a Malay student consumes food of the value of about 1,600 calories only.

Ventilation for workers, whether doing hard manual work or following some more sedentary occupation, should be varied within the limits necessary for maintaining an active metabolism. The condition of the atmosphere is only imperfectly ascertained by using ordinary wet and dry bulb thermometers; by these means, it is true, temperatures may be noted dangerous from the point of view of heat stroke or frost bite, but accurate information cannot be obtained as to the invigorating power of the atmosphere at ordinary temperatures. The use of the kata-thermometer for this purpose is advocated, and instances are quoted where it has been employed in industrial processes. Dr. Hill sees in exposure to moving and cooling air the influence which so increases natural metabolism as to maintain resistance against disease; hence comes an impulsion to activity rather than to sit still and feel chilled.

The time cannot be far distant when an agreed standard of ventilation as determined by the kata-thermometer will prevail in industrial establishments.—E. L. Collis.

COMPRESSED-AIR BLOWERS AS AN AID TO METAL-MINE VENTILATION. *R. V. Ageton.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2309, January, 1922.—The author shows by psychrometric, kata-thermometer, and anemometer measurements that compressed air blowers are unsatisfactory and that much better results are obtained by the use of suction fans furnishing fresh air from the surface. It is also shown that the latter method is much less expensive and its adoption is advocated.—Philip Drinker.

WHAT ABOUT OZONE? *E. Vernon Hill* and *John J. Aeberly.* Heating and Ventilating Mag., Jan., 1922, 19, No. 1, 37-40.—The present paper is a continuation of the authors' article in the December issue of the Heating and Ventilating Magazine, and details experiments on the action of ozone on galvanized iron ducts, with results that show no loss in ozone or oxidation of the zinc of the galvanized coat. Enameled sheet iron showed signs of oxidation on the walls of the ozonizing chamber. Odor tests using butyric acid for comparison gave more or less negative results, while several tests with bacteria laden air gave no conclusive evidence of the

germicidal value of ozone. By testing the mould on stale bread the authors concluded that the ozone had destructive properties. Gas masks were used in working with concentrations of over 100 parts of ozone per million.—Philip Drinker.

What about Ozone? *E. Vernon Hill* and *John J. Aeberly.* Heating and Ventilating Mag., March, 1922, 19, No. 3, 36-37.—This is the concluding paper of the series of articles on ozone by the same authors. The possibilities of using ozone as a deodorant and disinfectant in ventilation and in air conditioning are discussed, and a few data are given on its use as a germicide and in the destruction of vermin.—Philip Drinker.

Heat as a Means of Destroying Mill Insect Pests. *J. P. Calderwood.* Heating and Ventilating Mag., March, 1922, 19, No. 3, 25-26.—The use of heat as an insecticide, particularly in flour mills, is discussed, and examples are given of the successful application of heat, in summer, at a temperature of 130° F., for which a modern mill heating plant need be but little modified. A formula for calculating heating capacity required is given.

Hydrocyanic gas as an insecticide is claimed to be less applicable because of the danger incurred as well as because of the greater expense, as compared with heat.—Philip Drinker.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Dental Work as a Prophylactic Measure in Improving the Physical Condition of Employees. *T. P. Hyatt.* Am. Jour. Pub. Health, April, 1922, 12, No. 4, 325-327.—This paper is a brief review of the dental prophylactic work carried out by the Metropolitan Life Insurance Company for its office employees. In this company's dental clinic two cleansings of the mouth are given each year and X-ray examinations made of all teeth having crevices, bridges, or non-vital pulp. The X-ray examination has greatly helped in the improvement of the health and efficiency of the employees. A number of cases are cited where this examination has resulted in the removal of foci of infection, evidently responsible for chronic ailment of various types. The fact is noted that these patients with chronic focal infection almost always suffered markedly from fatigue.—H. F. Smyth.

Efficient Record Making in the Treatment of Industrial Disabilities. *Harry L. Langnecker.* Calif. State Jour. Med., Dec., 1921, 19, No. 12, 477-479.—The author emphasizes the necessity for better record keeping in the treatment of industrial disabilities. Methods should be simple, definite, and uniform, and should include every available detail. Sample record forms are shown, and the apparatus necessary for the estimation of deformity of the extremities, of back injuries and of foot disability are illustrated.—M. C. Shorley.

INDUSTRIAL NURSING

Part Time Industrial Nursing. *Nora Rowell.* Pub. Health Nurse, Feb., 1922, 14, No. 2, 85-86.—The object of part-time industrial nursing is to give to small factories, at a price that is not prohibitive, the same advantage of health supervision that the up-to-date big factory enjoys. The attitude of the small factory toward health welfare work is generally negative, simply because it has not been tried out. The objects of the work are:

1. Greater efficiency of the working force.
2. Diminished loss of time and suffering from preventable diseases.
3. Increased contentment of the workers.
4. Better spirit of co-operation on the part of the employees.

A friendly feeling is encouraged between the nurse and the workers. The nurse, coming in from a different angle than the foreman, can encourage a spirit of pride and

thus solve long-standing problems. The workers are encouraged to come to her, so that she may avoid diverting their attention from their work by going among them. A regular inspection of the factory, however, provides enough circulation among the workers to stimulate and maintain interest. — M. Mahoney.

INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

The Human Factor in Industry. IV. *C. H. Northcott.* Indust. Management, Jan., 1922, 63, No. 1, 36-41.—Much of the stunted development of workers in all countries or "their low standard of comfort" is due to the relative smallness of their wages. It is just that industry should bear the obligation of paying a sufficient reward, and parasitic industries that cannot pay their way on this basis are a burden to society and a curse to the workers.

With regard to the definition of just remuneration we have not advanced very far The National War Labor Board at Washington followed a standard which would ensure "the subsistence of the worker and his family in health and reasonable comfort." But no wage is fair that does not reward skill and effort in proportion as they are manifested; and a wage is not fair which does not increase with increased effort and increased output. As a practical means the rate-fixing adopted in some factories, in which a workers' rate-fixer and a company's rate-fixer confer and agree is good. But there is also a wider view since the "square deal" is so important in maintaining peaceful industrial relations, and one solution is the establishment of a wages department alongside of the employment department, the function of which is to determine fair wages in every part of the work.

Industry also owes its workers security, and for this an economic argument as well as a human argument can be proffered. Industry should make no significant difference between those who, in bad times, are unemployed, and those who are employed the whole time, since industry is always in need of a reserve. Only by guaranteeing some degree of maintenance during unemployment can the capitalist undertake fully the risks of industry and thus overthrow one of the most powerful arguments against continuance of the present industrial system. The human argument is obvious: unemployment is the dark shadow over the lives of workers. It inhibits co-operation and retards production because of the fear which it produces. Unemployment is a cause of both physical and moral deterioration. Present insurance plans are inadequate, but a recent plan worked out in Great Britain is more feasible. A rate was proposed according to which, varying with the size of family, etc., the unemployed man should receive a sum up to a possible 75 per cent. of his wages, the fund being provided by a levy of one penny in ten shillings of wages on the workers and a contribution of about 2 per cent. of the wage bill from the employer; and this has been made the basis of an unemployment benefit fund established by one firm.

Industry should afford time for leisure and recreation. The forty-eight-hour week is a maximum, but the plan to crowd the forty-eight hours into a five-day week is not defensible, although the forty-four-hour five-day week is practicable.

Equally important is mental satisfaction. The employee should be instructed in regard to the nature of the business, and should later have lessons in organization and in the function of the departments of the industry. In one case in which new employees were given introductory instruction of this kind this group "far surpassed any record for efficiency set up by their predecessors."

Regard for personality is the most important of all in the relations of industry to employee, and with the increasing mechanizing of processes it is harder to attain. All possible conditions favorable to health and comfort and contentment must be provided, therefore, and the "employer who will give time and money to make his workers comfortable is more likely to have efficiency and content within his factory."

There must be proper vocational selections; workers are more likely to develop into the

men and women they should be if the jobs to which they become attached fit them. Here the industrial psychologist functions. He alone can scientifically estimate a worker's capacities in respect to such qualities as dexterity, speed of perception and reaction, quickness and reliability of choice, accuracy, forethought, ingenuity, etc. Each industry owes those who apply to join it guidance as to their adaptability and suitability.

Work is physically satisfying and interesting only if it gives free play for one's instincts, including those of workmanship, domination and submission. Men have still a pride in work, but above all they want to feel that they count in industry. And they want some share in control over measures affecting their own lives. This means some type of industrial representation.

"To make of each worker an understanding contributor to the world's work, while not the ultimate end of life, is the most splendid end that industry can achieve, and the discharge of the debt that it owes him."—G. E. Partridge.

THE SERVICE OF NEUROPSYCHIATRY TO INDUSTRIAL MEDICINE. *H. W. Wright.* Calif. State Jour. Med., Dec., 1921, 19, No. 12, 464-468.—Labor turnover is a cause of much expense and trouble in industry; it is usually due to a faulty adjustment of the employee and to his susceptibility to influences. The maladjusted are usually constitutionally defective, psychopathic, psychoneurotic or physically sick. The industrial problem, therefore, needs to be considered from the standpoint of neuropsychiatry.

"Now, we all know what war neurosis is, and most of us are familiar with traumatic neurosis as seen in industrial life, and we appreciate that both are the result of the same essential factors, namely, a conflict between the instinctive tendency to withdraw from danger or discomfort to seek safety or ease, and the less primitive and, therefore, weaker tendency to stand by the social group and carry on with one's duties or burdens of life. And yet the results we are getting with traumatic neurosis in industrial life are deplorable! And this is because there is no well organized effort to diagnose it early and treat it early before the fixation of its symptoms."

What is the function of the neuropsychiatrist in industry? In part to eliminate the unfit, but more to enable the employer to retain his employees and fit them to work, to help the neurotic to adapt himself to difficulties through a better self-understanding. The psychiatrist's larger field of usefulness will be in dealing with borderline nervous and mental disorders and differentiating them from organic and incurable conditions.

The types of problems which the neuropsychiatrist will meet most in industry are: (1) the detection of the unemployable for any kind of permanent employment; (2) the proper placement of those who, though handicapped by nervous or mental defects, can be permanently employed — *e.g.*, the placement of the feebleminded and also of those having special abilities; (3) bringing about better feeling on the part of foremen and employers toward peculiar individuals having mental episodes, and a better understanding of those requiring change and rest; (4) early diagnosis and therapy of traumatic neurosis. In all of this work the aid of the laboratory psychologist and intelligence tester will be very valuable.

Examination should include a general interview, general physical and neurological examination, and a later interview when all available data are taken into consideration. The examiner should always make it clear that the examination is primarily for the benefit of the employee.

A very useful outline for examination is appended. This includes directions for taking the anamnesis; for mental examination with respect to appearance and behavior, spontaneous talk, mental attitude, orientation and memory, intelligence (to be tested by the Binet-Simon methods, Healy's modification of the Binet-Simon scale, and Ziehen's tests).—G. E. Partridge.

PERIODIC VARIATIONS IN EFFICIENCY. *Archibald G. Peaks.* Abstracted from Educational Psychological Monographs No. 23, 1921, in The Digest, Jan.-Feb., 1922, 4, Nos. 1-2, 2. —"On the assumption that there are periodic variations in mental and physical efficiency, experiments were made to determine

the periodicity of attention, muscle strength, primary memory, strength and endurance. The relation between conduct and weather, civilization and climate, the effect of weather on the ability to learn, the effects of variations in the sunlight, effects of changes in temperature, effects of variations in the humidity—all these in so far as they affect personal efficiency are taken up in turn."

INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

Health and Welfare in the Coal Mining Industry. *Edgar L. Collis.* Jour. State Med., Jan., 1922, 30, No. 1, 15-27.—One of the aims of welfare work in this industry is the reduction of excessive labor turnover by dissuading unsuitable persons from engaging in coal mining. In the mines, there are several matters needing serious attention. Clean drinking water is an important necessity for the miner and a supply carried to the workings would be of great benefit to prevent his recourse to dangerous underground water. The inauguration of colliery kitchens from which freshly cooked food could be sent to the workings would be a healthful improvement over the "picnic" lunches that the miners now have to eat. Pithead baths for the miners are considered a highly important factor in promoting their moral and social, as well as their physiological well-being.

Underground lighting stands in urgent need of improvement since poor illumination is largely responsible for many accidents and for nystagmus. Another health question is the occurrence of beat-hand, beat-elbow and beat-knee, of which there were 2,772 cases claiming compensation in 1914, and an inquiry should be set on foot to ascertain whether this condition and bronchitis and pneumonia, from which miners in certain coalfields suffer in excess, are not preventable.

For the reduction of accidents, safety-first methods should be impressed upon the miners. Investigations have shown that certificated illness rises and falls with so-called avoidable absences, which means that so-called absenteeism is governed by influences controlling actual sickness.

Outside of working hours, a helpful influence may be exerted by providing acceptable means for recreation, such as gardening, and for educational improvement. Establishment of competent electric massage institutions to treat injuries of muscles of the back and limbs of miners is recommended.

When the mortality rates of coal miners for 1910-1912 are compared separately for the seven great coalfields of Great Britain with the strike ballots of the miners taken in the summers of 1920 and 1921, a curious thing is noticed. The different fields voted for a strike according to their death rates. This observation would seem to indicate that the usual reasons given for social unrest are merely conscious efforts to explain unconscious impulses, and that these unconscious impulses are founded upon ill health.—Barnett Cohen.

Change-Houses for Workmen. *C. Lorimer Colburn.* Nat. Safety News, Jan., 1922, 5, No. 1, 29.—This article deals with types of change-houses for mine workers and other industrial employees.

A satisfactory change-house is that used by the Utah Fuel Company, at the Castelgate No. 2 mine, where hooks are provided so that the clothing of the workmen can, by means of a cable over a pulley, be elevated near the ceiling where there is plenty of warm air. Benches conveniently placed on the concrete floor provide for the men when changing their clothes. After hanging their clothing on hooks, they elevate the hooks, a padlock making it impossible for anyone else to lower a man's hook after it is drawn up.

The New Jersey Company at Franklin, N. J., uses lockers for its change-house. By use of a blower system, fans, arranged at the roof of the building, suck the air through the lockers and discharge it through the roof. "Steam pipes run through the lockers and furnish the heat necessary to dry the clothes."

Toilet rooms and shower baths are placed conveniently in both change-houses.—M. C. Hamblet.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

Labour Legislation Arising Out of the International Labour Conference. Internat. Labour Office, Official Bull., Nov. 16, 1921, 4, No. 20, 431-438.—Bills giving effect to the Draft Conventions and Recommendations adopted by the Washington Conference have passed their first reading in the Brazilian Chamber of Deputies. The bill relating to the employment of women makes effective certain provisions about night work and the employment of women before and after childbirth, and also the recommendation concerning the protection of women and children against lead poisoning. The bill dealing with employment of children fixes the minimum age for admission of children to industrial employment, regulates the night work of young persons employed in industry, and follows also the recommendation for protection against lead poisoning.

The bill concerning women contains twenty-three paragraphs. It prohibits the employment of women in certain occupations, such as mining, and in establishments where conditions are prejudicial to the constitution of women, and also in night work. Hours of labor are limited to eight, with a minimum rest of one-half hour. Every worker shall be entitled to a rest period of thirty days preceding and forty days following childbirth, with two-thirds wages, and the position of the worker must be kept open for her. Time without deduction of pay is allowed the nursing mother. Provisions are made for protection from hazards likely to affect women in the period of pregnancy, and for the establishing and maintenance of nursing rooms. The employment of "female young persons" as actresses, etc., in circuses, café concerts or theatres is prohibited. Except when necessary, male workers are not to be employed in the same room with female workers.

The bill concerning the employment of children contains twenty-five paragraphs. Children of either sex under 14 years—with certain exceptions—are not to be employed. Children, when admitted to employment, shall not be employed more than six hours a day, and shall have a right to thirty-six consecutive hours a week for rest. Certain occupations are prohibited to young persons under 18 years. The Ministry of Labor may at any time forbid the employment of a child if the state of health is not such as to allow heavy labor. In establishments of all kinds where children are employed, employers shall be obliged to maintain their plant in the "most perfect working order," and to provide suitable protection against dangerous machines and tools. Children covered by the act are not to be employed on piecework, or work by contract, or overtime, etc.

Adoption of the Berne Convention of 1906 on the prohibition of the use of white phosphorus in the manufacture of matches is also reported.—G. E. Partridge.

INDUSTRIAL MORTALITY AND MORBIDITY STATISTICS

Coal Mine Fatalities in the United States and the United Kingdom. Internat. Labour Rev., Jan., 1922, 5, No. 1, 139-144.—Statistics in regard to mine fatalities during the years 1913-1920 are presented in eight tables. The number of workers employed and the fatality rate for each year are given, and the death rate for the period considered is compared with that of other periods. Fatality rates in metal mines in the United States are compared with those for the United Kingdom (they are about three times as high in the United States); fatality rates in quarries are also shown, those for the United States being higher, but not to so great an extent as in metal mines. In coal mining, however, the rate in the United States exceeds that in the United Kingdom in about the same proportions that hold for metal mining. Coal mine fatalities in the United States and the United Kingdom are shown also with reference to their causes. In both countries falls of ground account for about 50 per cent., and underground and shaft accidents for about 90 per cent. Progressive improvement is shown in the United Kingdom in regard to coal mine fatalities, but not in the United States.—G. E. Partridge.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

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CONTENTS

GENERAL

ADDRESS ON INDUSTRIAL HYGIENE. *J. G. Cunningham.* Nat. Hyg. and Pub. Welfare, Jan., 1922, 58, No. 1, 54-63.—This paper touches briefly on several points of interest to the industrial hygienist: inheritance of effects of industrial poisonings; infant mortality in communities having a high percentage of industrially employed women; industrial medical examination for young persons entering industry as practised in Great Britain; standardized classification of industries and types of industrial disease; specific hazards and general hazards. There are some interesting reviews and opinions in regard to the present status of lead poisoning, tuberculosis, and cancer in relation to industrial conditions as predisposing causes.—G. E. Partridge.

SICKNESS FREQUENCY AMONG INDUSTRIAL EMPLOYEES. U. S. Pub. Health Ser., Pub. Health Rep., Jan. 6, 1922, 37, No. 1, 2.—The report relates to morbidity among wage earners, as shown by data provided by some manufacturing companies and benefit associations covering the period from January, 1920, to June, 1921. The items refer to disabilities lasting one week or longer. Most of the associations have age limits and restrictions, so that the report represents a "minimum statement of disabilities actually occurring."

Frequency of the disease groups is shown in two tables and a chart, and is given for each month of the period. It appears that serious illness was about twice as frequent in the winter of 1920-1921 as in the summer

of 1920. In general, the rate was higher in 1921 than in 1920. The digestive diseases show no greater prevalence in the warm weather, but respiratory diseases were about three times as frequent in February, 1921, as in June of the same year. The seasonal variation of the four most important causes of disability—tonsillitis, bronchitis, rheumatism, and pneumonia—is shown in a chart with curves plotted on a logarithmic basis. The seasonal fluctuation of the four diseases "appears to be fairly similar, though there is a tendency for the peak of the curve of rheumatism to be reached a month or two later than the time at which the other three diseases are most prevalent." There was a wide difference in the morbidity rates for different benefit associations, one having four times as many cases per 1,000 as another, and a severity rate represented by 10.27 days as compared with 1.54 in the other.—G. E. Partridge.

Sickness among Office Employees. *Dean K. Brundage.* U. S. Pub. Health Ser., Pub. Health Rep., March 10, 1922, 37, No. 10, 527.—This is a report of one year's experience of a large manufacturing company in the Middle West which recorded the number of hours lost from work by each office employee on account of sickness and accidents. The average number of persons employed during the year ending January 31, 1921, was 1,282, with women in the majority; and the average age of the group was 23.7 years. There were two cases of disabling sickness per person, and the average number of working days lost per case was 3.8. Over 9 per cent. of all dispensary calls were due to minor infections, yet not a single case of disability from purulent infection developed. Common ailments, colds, rhinitis, headache and sore throat, were responsible for the greatest amount of disability. Sex is a considerable factor in disability; the departments having the largest proportion of men had the lowest illness rates. Fatigue caused a surprising amount of disability both in duration and incidence. The average duration of 11.66 working days per case of fatigue was by far the longest of any of the fifteen most frequent causes of disability. —Barnett Cohen.

Ship Sanitation and First Aid for Merchant Seamen. U. S. Pub. Health Ser., Pub. Health Rep., March 31, 1922, 37, No. 13, 758.—"The Secretary of Commerce has recently approved an amendment to the general rules and regulations prescribed by the Board of Supervising Inspectors, which requires that no candidate for original license as master, mate, pilot or engineer shall be examined unless he has completed a course of instruction in 'first aid' approved by the U. S. Public Health Service and has passed an oral examination based on a Manual of Ship Sanitation and First Aid recently prepared by the Public Health Service in co-operation with the Seamen's Church Institute of New York City."—Barnett Cohen.

Some Recent Reports on Vocational Selection in England. *D. R. Wilson.*—Until recently the terms vocational guidance and vocational selection were almost unknown in England, notwithstanding the large amount of work on these subjects carried out in other countries, notably in the United States and Germany. Even during the war when the need for the rapid and successful filling of vacancies was especially acute, work on vocational selection was confined to a few specialized branches of the fighting forces (1) (2) (3), and nothing was attempted comparable with the extensive classification of the personnel in the United States army (4), or the selection in Germany of women workers for the printing trade (5) (6) and for street car driving (7).

Within the past two years, however, there have been signs of increasing interest in the subject. The Industrial Fatigue Research Board, for instance, has included the scientific study of the problem within its sphere of work, and the National Institute of Industrial Psychology has now been established with the object of developing vocational guidance on practical lines.

Under the circumstances the English literature on the subject is at present small, but a few reports and papers dealing with original research on vocational tests have already been published. In the earliest of these (8) issued by the Industrial Fatigue Research Board (which has already been re-

viewed in the Abstract Section of THIS JOURNAL, May, 1922, 4, No. 1, 2) the whole of the literature on the subject has been reviewed.

More recently a new report from the same source has appeared, containing an account of three investigations on the subject (9). The first study is based on an investigation conducted among compositors, readers, and monotype keyboard operators in two printing works. The procedure adopted was as follows:

1. The work was closely observed and the particular capacities that seemed to be demanded by it were noted.

2. Suitable tests of these capacities were devised.

3. The operators were graded from an independent source, generally from the opinion expressed by the manager or foreman as to the proficiency of each individual.

4. The tests were applied and a second grading based on these tests obtained.

5. The two gradings were compared, and by applying the method of partial correlation, such tests as were shown to be unnecessary or undesirable were eliminated.

6. The independent grading was correlated with a grading based on the remaining tests.

In the case of compositors, the following capacities were first tested as the result of observation of the work:

a. Dexterity (*match stick insertion test*).

b. Rapidity of observation (*two cancellation tests*).

c. Immediate memory (*substitution test*).

d. Visual perception of form (*form board test*).

e. Intelligence (*directions test*).

Of these, one of the cancellation tests, the form board, and substitution tests were subsequently discarded, and the final results based on the remaining three tests.

The results obtained at one of the works may be graphically represented by Figure 1. The ordinates are the ranks for the tests—that is, "1" indicates the *rank* of the compositor who made the best performance in the tests; "2" that of the compositor who made the second best performance, and so on. The abscissae are the ranks for composing efficiency. The position of the fourth dot, for instance, indicates that the compositor who was fourth in the tests was also fourth in composing efficiency. The straight diagonal line indicates a possible absolute correspondence between the rankings for composing and total efficiency in the three tests (an r of $+1$.) The dots represent the individual compositors. The degree of correlation is indicated by the nearness of these dots to

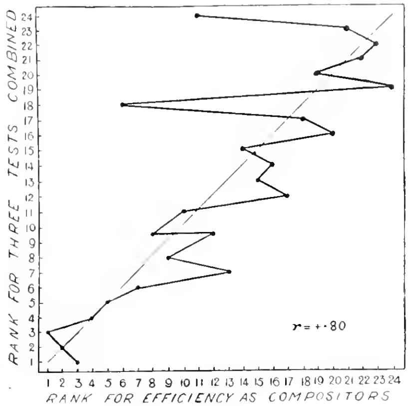

FIG. 1.—Graphical representation of the degree of correlation at a printing works between composing efficiency and total score in the *Cancellation*, *Match Stick Insertion*, and *Directions* tests.

the straight diagonal line. If a dot falls on this line, the compositor indicated by it occupies exactly the same position in the test and work rankings. While this seldom happens, the distance of the dots from the line of perfect correlation is rarely considerable.

Similar results were obtained in the case of the compositors in another works, the coefficient of correlation here being $+0.71$.

On the general significance of these results, Muscio emphasizes the fact that composing efficiency does not depend solely on the possession by the compositor of the psychophysiological capacities measured by the tests, but also on other factors, such as trade knowledge, general health, application and ambition, not affecting efficiency in the tests. Hence, perfect correlation between

efficiency in the tests and composing efficiency could not in any case be expected, but the high correlation coefficients obtained indicate that the functions brought into operation in the performance of the tests are nevertheless distinctly important in composing efficiency. Some preliminary tests were also carried out on readers and monotype keyboard operators.

The second and third studies in this volume are of special interest in that they deal with vocational selection on a non-psychological basis, with the consequent recognition that in selection for industrial work physical and physiological qualities must also play an important part. In the second study the author deals with the measurement of physical strength of 2,300 youths in Manchester and industrial Essex. He points out that many forms of work make special physical demands on the worker, and that inadequate muscular development induces unnecessary fatigue and inefficiency,* and suggests tentatively that, with regard to the subjects tested, possibly 10 per cent. of those who become engineering apprentices do not possess the physique required for engineering work, so that some decrease in fatigue and inefficiency could be effected by guiding these persons into vocations where physical strength is not required and by substituting for them others of more adequate physique. His other conclusions are:

"(i) that the muscular strength test devised by Martin [10] (based on tests for certain groups of muscles) is unsatisfactory for general industrial work, chiefly because results obtained by it are partly a function of the particular operator:

"(ii) that a combination of grip and weight gives a useful indication of general strength, though a better indication would almost certainly be obtained by the addition of a suitable test of the strength of the forearm flexors;

"(iii) that the Essex adolescent males engaged in engineering are consistently superior physically to Manchester adolescent males engaged in the same type of work."

*A careful distinction, however, is drawn between physical strength and *endurance*, and the investigation is concerned solely with the measurement of the former.

A set of percentile tables is appended by the use of which the general strength of an individual may be estimated from his grip and weight.

The third study is based on a somewhat similar investigation conducted among girls employed in a confectionery factory. The subjects selected were manual workers, paid on a piece rate system, and the measurements taken were chiefly those of the arms, hands, and fingers. In each process the workers were divided into two groups (A and B), composed of those whose output was high and low respectively, and the physical types of both groups compared so as to ascertain whether proficiency is related to any particular type.

The results indicate that two distinct types exist, designated long-spanned and short-spanned, and that the long-spanned type manifests itself in the A group among the packers, and in the B group among workers in the packet department and dippers, suggesting that a long span is desirable for packing and a short span for the other kinds of work. This conclusion, however, cannot be regarded as definite until it is known how far the occupation itself develops these characteristics; in packing, for example, the fingers are constantly used in an extended position; in the other classes of work the exact opposite is the case.

A more intensive treatment of the data (by the method of correlation) led to rather indefinite results, and the conclusion reached is that while the physical type appears to play a part—though a small one—in proficiency in work, it is related to the work in question and not to any *general* characteristics making for proficiency, and that there are other and more powerful factors connected with proficiency which cannot be arrived at by physical measurement and which tend to mask the influence of physical type.

The most recent paper on the subject of vocational selection (11) deals with tests for clerical occupations. It is practically limited to a description of the methods adopted, the full results not yet being available. The tests were devised for application to those who at the time of testing profess

to have been trained in their work and who appear as candidates for particular appointments, and not for ascertaining whether untrained beginners possess such capacities as to make it worth while submitting them to the requisite period of training. The investigation, therefore, deals rather with the measurement of proficiency than of aptitude.

The method of procedure adopted was as follows:

1. A preliminary series of tests was carried out on a few experienced persons, such as students of psychology with practical acquaintance of clerical duties. With their assistance, unsatisfactory tests were modified or eliminated, and the procedure was mended and improved.

2. Of the tests thus selected, the more important were applied to about a hundred schoolchildren aged 13 to 15, principally with the object of grading the test questions more uniformly and of arranging them in the order of increasing difficulty.

3. Lastly, the tests so re-arranged were applied to thirty typists in the office of an education authority, who were graded by the supervision of the department in order of merit from the point of view of clerical efficiency. The correlation between the tests and the independent order was then determined.

The tests themselves included:

1. Four graded tests of intelligence.

3. Two tests of linguistic ability and tainments.

3. Two tests of linguistic ability and general information.

4. Tests of typewriting and shorthand writing.

a. Shorthand (graded speed and outline tests).

b. Typewriting (speed tests, tests of accuracy and display, and manuscript reading).

The full results of the investigation are not yet available, but the author states that the correlation coefficients already obtained are sufficiently high to warrant the immediate practical use of the tests.

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SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

CIRCULATORY SYSTEM

Potential Cardiac Disease and Prevention of Organic Heart Disease in Children. *William St. Lawrence.* Jour. Am. Med. Assn., April 1, 1922, 78, No. 13, 947-952.—The author summarizes as follows:

"1. Sixty-five cases of potential cardiac disease in children were continuously observed for an average period of four and one-half years.

"2. Forty-nine patients (75 per cent.) remained free from evidence of cardiac disease during that time.

"3. Of twenty-five patients with acute rheumatic fever in the series, none contracted a lesion in the heart.

"4. Of nine patients with myositis, bone and joint pains (growing pains) and sore throat, none contracted a lesion in the heart.

"5. Sixteen patients (25 per cent.) con-

tracted a cardiac lesion while under observation.

"6. In every case in which a cardiac lesion developed, the clinical picture was dominated by chorea in a severe form. No patient contracted a lesion in the absence of this manifestation.

"7. Of forty-one patients with chorea in the series, sixteen (39 per cent.) contracted a lesion in the heart.

"8. Measures of value in preventing disease of the heart are of greatest benefit when directed against acute rheumatic fever and myositis, bone and joint pains (growing pains) and sore throat.

"9. Such measures have little if any value when directed against chorea.

"10. In untreated potential cases, acute rheumatic fever is the most important factor concerning disease in the heart.

"11. In potential cases under management, chorea is the most important factor concerning disease in the heart.

"12. With the exception of mitral stenosis, cardiac lesions practically always occur during the active phase of a rheumatic manifestation or a period of pyrexia. In the absence of an active phase, the physical signs in the heart remain unchanged.

"13. Evidence of mitral stenosis may not appear for a year or more after the cessation of the rheumatic manifestations. It is therefore impossible to state at the conclusion of an attack of acute rheumatic fever or chorea that the heart was unaffected by these conditions.

"14. Heart rate may have a marked effect on the physical signs of mitral stenosis, as shown by a graphic record."—C. K. Drinker.

HEART DISEASE IN INDUSTRY. *Cadis Phipps.* Jour. Am. Med. Assn., Feb. 25, 1922, 78, No. 8, 562-564.—Reviewing the records of 650 cases examined for the Massachusetts Industrial Accident Board, Phipps found that in 231 cases there was an organic heart lesion or else there were symptoms directly referable to some functional disturbance, such as a marked arrhythmia with premature contractions. These cases were divided as follows:

Condition	Number of Cases
Mitral regurgitation	94
Mitral stenosis	36
Aortic regurgitation	6
Aortic stenosis	2
Aortic and mitral regurgitation	5
Tricuspid regurgitation	1
Acute myocarditis	1
Paroxysmal tachycardia	3
Auricular fibrillation	28
Pulse alternation	2
Myocardial degeneration	8
Arrhythmia and premature contractions	39
Pericarditis (plastic)	2
Heart block	1
Coronary sclerosis	3

The author then comments on the apparent effects of work, trauma, fright, etc., upon this group of workers who have a definite circulatory handicap, and closes with the following paragraphs:

"Summing up some of the more common injurious agents, we find that trauma is the chief factor in industry to affect the heart, occurring as it does in forty-seven of the 231 cases. Lead, occurring in twenty-five cases of different types, and other metallic poisons in nine cases (arsenic had previously been noted by Graham Steele) suggest their probable etiology and also more energetic methods of prophylaxis. Fright, occurring in ten cases, is undoubtedly an etiologic factor in producing the arrhythmias. Caisson work may easily be a cardiac menace, and the customary examination of each workman before entrance into the lock should not be restricted to ear-drums and the upper respiratory passages, but should include a careful examination of the heart.

"In view of the fact that most of the employees examined were supposedly incapacitated for some physical reason, it is surprising to note the large number of cases showing no cardiac symptoms. This is particularly true in regard to mitral regurgitation, in which sixty-eight of the ninety-four patients, or 72 per cent., complained of nothing referable to the heart, while twelve more had but slight symptoms."—C. K. Drinker.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Carbon-Monoxide Poisoning. *Alice Hamilton.* U. S. Bur. Labor Statis., Indust. Accidents and Hyg. Ser., No. 291, Dec., 1921, pp. 47.—"Industrial carbon-monoxide poisoning is said to be increasing in all civilized countries because of the increasing use of power and producer gas, the increasing use of motor engines, and the increasing depth of mines with the consequent difficulty of ventilation and seriousness of accidents. British statistics show that the average number of cases per year increased during the last quinquennium from 62.5 to 75 and the mortality from 12.3 to 17.3 per cent.

"Studies in European countries, especially Great Britain and France, show that industrial carbon-monoxide poisoning when not fatal is sometimes followed by serious effects, such as pneumonia, cardiac weakness, mental disease, or paralysis. Such after-effects are seen most often in coal miners.

"Chronic carbon-monoxide poisoning is described, though not clearly, by the French, English and Germans. It is supposed that the ill health complained of by cooks, bakers, laundresses, ironers, pressers in tailor shops, painters working in rooms dried by salamanders, etc., is caused by the coal gas in the air.

"Inquiries made in the United States show that acute carbon-monoxide poisoning occurs in steel manufacture, in making illuminating gas, in making coke (by-products), in using producer gas for industrial processes (especially in smelting), in coal mining, metal mining, zinc smelting, and in garages when the exhaust gases from engines accumulate.

"American statistics as to the number of cases and of fatalities are available only to a very slight extent. The figures from one of the steel companies show a decidedly lower mortality (4.8 per cent. for 1916 to 1920) than the British mortality from blast-furnace gas (22.8 per cent. for 1914 to 1919). The figures from the American Gas Institute show that among some thousand accidents during 1919 only 30 were due to gas and none was fatal.

"No statistics are available for carbon-monoxide poisoning in coal mines or in metal mines, the reports of the Bureau of Mines not distinguishing this cause of death and disability from others.

"A careful search in steel towns and in coal mining and metal mining towns failed to confirm the statements made by foreign authorities as to serious after-effects from gassing accidents. Only very rare instances of such a character were discovered. It is not possible in our present state of knowledge to explain why experience in this country differs so much from that of European observers. A more thorough study should be made of this aspect of industrial carbon-monoxide poisoning.

"The suggestion is made that some of the obscure features of poisoning by this gas may be cleared up when it is known just what other constituents besides carbon monoxide are present in a given industrial gas, and just what effects might be produced by these other gaseous bodies. It is especially suggested that small quantities of benzol may be really the active agent in cases attributed to carbon monoxide.

"Chronic carbon-monoxide poisoning may be looked for in industries in which small quantities of the gas are more or less continuously present in the air.

"Of 55 garage employees, mechanics and storage men, 36, or about two-thirds, were shown to have absorbed in their blood carbon monoxide in demonstrable quantities. Of the remaining 19 only 9 had been at work inside the garage for more than an hour when the test was made.

"Of 47 linotypists in newspaper plants where the gas from the lead pots is not carried off by an adequate suction apparatus, 8, or over one-sixth, showed the presence of carbon monoxide in their blood. The actual effect of such constant absorption of small quantities of this gas should be studied further."—*C. K. Drinker.*

Gangrene from Illuminating Gas. *Garnier* and *Cathala.* Abstracted as follows from Bull. et mém. Soc. méd. d. hôp. de

Par., Feb. 17, 1922, 46, No. 6, 304, in Jour. Am. Med. Assn., April 22, 1922, 78, No. 16, 1234.—"Intoxication with illuminating gas was responsible for the arteritis of the terminal arteries entailing patches of gangrene."—C. K. Drinker.

THE GROWING MENACE OF BENZENE (BENZOL) POISONING IN AMERICAN INDUSTRY. *Alice Hamilton.* Jour. Am. Med. Assn., March 4, 1922, 78, No. 9, 627-630.—The author states that prior to the war benzene poisoning was a rarity in this country. In 1915-1916, however, she was able to collect fourteen instances of sudden acute poisoning, with seven deaths. The men involved were pipe fitters or workmen engaged in distilling benzene or cleaning tanks, or, in two instances, sulphonating benzene as a step in the production of phenol.

Benzene is apparently extremely toxic. Lewin has described a case in which a benzene kettle which had been empty for twenty-two hours was "washed out twice with steam and three times with cold water, and then it was allowed to stand all night filled with cold water. As the workman went in, a strong current of air was blown in through a pipe. In spite of all these precautions he was overcome and fell to the bottom of the tank. Several of his fellow workmen tried to get him out, but all grew dizzy and confused, and had to give it up. Finally, an engineer in a diver's helmet succeeded in rescuing him, and he was revived; but one of the workmen who had helped in the rescue died within ten minutes of inhaling the fumes."

Other cases illustrating the toxic powers of benzol are given and it is suggested that white mice be placed in possible benzol atmospheres prior to the entrance of workmen.

The pathology of acute poisoning is apparently not significant, consisting of a tendency to incoagulability of the blood and petechial hemorrhages. Chronic poisoning has occurred most notably in rubber factories and has as its most important symptoms aplastic anemia with its accompanying symptoms, the most notable in this case being the tendency to bleeding from the gums and petechial hemorrhages. Headache, lassitude, anorexia, loss of weight, abdominal pains, and vomiting also occur. The pathology of chronic poisoning is found in the effect of the benzol upon leukocytes, platelets, and megacaryocytes, and upon the erythrocytes. These elements in blood and bone marrow are affected in the above order but in extreme cases all are markedly reduced, the bone marrow becoming aplastic.

In regard to prevention the author calls attention to Lehmann's observation that two to three parts in 100,000 may cause loss of consciousness, and that prevention must therefore rely on extremely efficient ventilation.—C. K. Drinker.

OCCUPATIONAL PURPURA. *C. Flandin* and *J. Roberti.* Abstracted as follows from Bull. et mém. Soc. méd. d. hôp. de Par., Dec. 30, 1921, 45, No. 39, 58, in Jour. Am. Med. Assn., March 18, 1922, 78, No. 11, 848.—"The young woman had been employed for nearly two months in an automobile factory, working with rubber dissolved in benzol, in what was called the 'heating room.' Three or four men and two women were employed in this unventilated room; they were entitled to leave it frequently to breathe purer air. Headache, dizziness and pallor had been followed by hemorrhagic purpura, with fever, acute anemia, and death within three weeks. There had been three previous cases of purpura within six months in the persons employed in this room, but only one was fatal. Some recent research indicates that commercial benzene (benzol) is more toxic than crystallizable benzene, and that this is more toxic than benzene obtained from calcium benzoate. Persons using benzol should have their blood examined frequently."—C. K. Drinker.

BLOOD STUDIES IN SUSPECTED LEAD POISONING. *G. Seiffert.* München. med. Wchnschr., Dec. 9, 1921, 68, No. 49, 1580-1581.—The author points out the urgent need of using blood examination, made easier by the new "thick drop" method, in all cases where lead poisoning may be reasonably suspected. Lead poisoning is increasing in incidence. Munich has a new public laboratory for industrial hygiene where such examinations are made free for any physician.

Experimental Tar Cancers. *J. Fibiger* and *F. Bang.* Abstracted from the Hospitalstidende, Nov. 30, 1921, 64, No. 48, 51, in Jour. Am. Med. Assn., March 4, 1922, 78, No. 9, 696.—"Fibiger's article is published in Society Proceedings, with separate paging. He gives a historical sketch of the cancers that have been found in man from irritation with soot, pitch, etc., from Pott's first description of chimney sweeps' cancer in 1775 to date, and reviews his own work with cancers induced in mice by painting the back with coal tar. He has been more constantly successful in this line than others so far, fully twenty-four of his twenty-six mice developing carcinoma (carcinoma-sarcoma in two) and the other two developing papillomas. One carcinoma was transplanted through four generations in four months, with 'takes' in from one to six of the animals in each generation. In Fibiger's 100 cases of spiroptera cancer in the mouse stomach he found only one that had induced metastasis in glands. [A more recent communication from Fibiger reports metastasis in twenty-two of eighty-six mice with tar carcinomas or sarcomas. The metastasis was in the axillary glands and lungs in most of the animals but occasionally in the heart or glands elsewhere. The young mice developed the cancers as readily as the older mice. He adds that Seedorff in his institute at Copenhagen has succeeded in inducing an actual adenocarcinoma in the mammary gland of a mouse treated with minute amounts of tar over a long period; this is the first experimental mammary adenocarcinoma to be published. Fibiger remarked that these tar cancers put the finishing stone to Virchow's theory of the causal importance of irritation in cancer, but the fact that cancers do not invariably develop proves that a predisposition is indispensable. There seems to be also an organ predisposition; he has never succeeded in inducing a spiroptera cancer in the esophagus of the animals, in his hundreds of attempts. Only the stomach develops these spiroptera tumors. He adds that it is dubious whether even aberrant embryonal cells are capable of developing cancer without some extraneous irritation to start them to malignant growth. His article appeared in the *Deutsche medizinische Wochenschrift* of Dec. 1 and 8, 1921.]

"He cites about fifteen research workers who between 1889 and 1916 had been striving to induce malignant tumors by repeated application of pitch, tar, anilin, etc. All were on the right track, but none kept up the experiments long enough until the Japanese reported in 1918 their success in twelve of 200 rabbits, with glandular metastasis in three. Fibiger and Bang have obtained positive results in 90 per cent. of the white mice which survived for at least three months after the first painting with the tar. Tsutsui has reported 50 per cent. of 'takes,' and Bierich up to 60 per cent. Rabbits seem to be less susceptible than white mice. The attempts to induce sarcoma of the liver in rats with cysticercus infection have always failed although sarcoma of the liver is comparatively common in wild rats infested with cysticercus. Only one instance is known in a house mouse."—C. K. Drinker.

Experimental Production of Tar Carcinoma. *B. Lipschütz.* Wien. klin. Wchnschr., Dec. 22, 1921, 34, No. 51, 613-614.—Painting of gray mice with coal tar resulted in the production of tar carcinoma in about 45 per cent. of the mice. The first distinct macroscopic changes were observed in from 88 to 125 days. Transplantation of the warty neoplasm was successful in two instances. There is a marked increase in the skin pigmentation of the animals, even in those not painted with tar, but having tissue transplants. A peculiar cyst formation occurring in one animal is described.—Barnett Cohen.

DUST HAZARDS AND THEIR EFFECTS

Drilling and Dustiness of Metal-Mine Air. *D. Harrington.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2339, March, 1922.—"The dust studies to date in metal mines of the United States by the U. S. Bureau of Mines indicate definitely that wet drills as used in drilling of all classes of holes aid decidedly in reducing dustiness

of air in drilling places. However, it has been found that wet drills whether of the Leyner type or stopers, if not operating satisfactorily or if out of repair, may throw into the air of working places a mist or fog laden with minute mineral particles, which when breathed has the same effect as dry dust and is fully as dangerous. In addition to danger when wet drills are not efficiently used, if water or compressed air and water forced through the drill is under excessive pressure, say over 100 pounds per square inch, there may be danger of escape of mist or fog laden with mineral particles, hence these pressures should be held below 100 pounds per square inch which, in general, is the practice in the United States.

"Wet drills must be kept in repair and must be operated with intelligence; as far as proved by the sampling of the U. S. Bureau of Mines, the wet drills, even when at their worst, still give conditions much more healthful than do dry drills."—M. C. Shorley.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Facts on Tuberculosis in Czechoslovakia. *Jaroslav Hálka.* Prague, 1922.—This publication is a study of tuberculosis in the Czech Provinces and in other countries. It contains thirty-three excellent diagrams and maps in which the prevalence of the disease is exhibited. Interest attaches to the fact that in Czechoslovakia, where industrialism is a comparatively recent development, the curve of tuberculosis by age periods closely resembles that which prevailed in England in 1851; it supports the contention that industrial development is associated with an increase of tuberculosis which especially affects young adult life. The disease in the Czech Provinces is most prevalent where industrialism is most prevalent. In the seventies Silesia, which is now particularly industrial, had the lowest mortality, and Moravia the highest. Today Silesia stands highest. When the thirty-two cities of the Czech Provinces are arranged according to tuberculosis death rates, those which are industrial stand at the top of the list.

The effect of the world war upon the disease is shown. It caused a rise in different countries and towns which was proportional to the stringency of food supplies. Tuberculosis is now on the decline in the Czech Provinces, but the incidence remains far higher than that experienced in other countries, such as England and America. The type of the disease resembles that found elsewhere, both in the way in which it attacks males and females, and in that about 83 per cent. of all tuberculosis deaths are due to pulmonary tuberculosis.—E. L. Collis.

Chronic Infectious Arthritis: Statistical Report, with End-Results. *Frank Billings, George H. Coleman,* and *William G. Hibbs.* Jour. Am. Med. Assn., April 15, 1922, 78, No. 15, 1097-1105.—This paper is an analysis of the age of incidence, duration, occupation, type of joint involvement, foci of infection, bacteriology, treatment, and end-results in 411 cases of chronic arthritis under observation between 1905 and 1921. The conclusions reached are as follows:

"This clinical investigation confirms and substantiates the present point of view of a majority of clinicians who have had the opportunity to make a careful investigation of chronic deforming arthritis, that it is primarily an infectious disease, and that the infectious micro-organisms which are the cause are usually strains of nonhemolytic streptococci of relatively low virulence, or occasionally strains of nonpyogenic gonococci or even of other bacteria of mild pathogenicity.

"The cause of the remarkable transformation of the fibrous tissues which enter into the joint structure and also of muscle tendons, into bone, is an interesting subject for future investigation. If the remarkable results of the animal experiments reported by Oxhausen can be substantiated, it may be possible to apply preventive measures which will obviate these disabling, irremediable secondary morbid changes."—C. K. Drinker.

The Rôle of Trauma in Lesions of Syphilis: With Particular Reference to the Hereditary Type. *I. Harrison Tumpeer.* Jour. Am. Med. Assn., Jan. 21, 1922, 78, No. 3, 185-187.—The author summarizes as follows:

"1. Trauma may excite lesions in individuals with acquired syphilis whose infection is dormant.

"2. Bone changes, gummas of the soft tissues and paretic brain changes are the usual manifestations.

"3. Trauma may act as the exciting cause in the production of lesions in individuals with hereditary syphilis whose infection is dormant and even unsuspected.

"4. A girl with hereditary syphilis, possibly of the third generation, developed epileptiform seizures and mental disturbances following a head injury causing coma.

"5. Her half brother, likewise infected, developed primary optic atrophy following similar trauma. The healing of the fracture produced by the same injury was markedly retarded."

In conclusion he states:

"Trauma may incite the localization of a syphilitic lesion in an individual with a quiescent infection, acquired or hereditary, probably by producing a locus minoris resistantiae."—C. K. Drinker.

Hemorrhagic Meningo-Encephalitis in Anthrax: Report of Case. *B. Shanks.* Abstracted as follows from Indian Med. Gazette, Nov., 1921, 56, No. 11, 418, in Jour. Am. Med. Assn., Jan. 21, 1922, 78, No. 3, 247.—"The case described by Shanks illustrates the characteristic and interesting hemorrhagic lesions which occur in the meninges and brain as a result of their infection with the bacillus of anthrax. In this case an anthrax bacteriemia resulted from a malignant pustule of the face, and gave rise to secondary lesions in the brain, intestines, and parotid."—C. K. Drinker.

Observations on an Extensive Human Infection by Sarcoptic Mange of the Horse. *R. A. S. Macdonald.* Lancet, April 15, 1922, 1, No. 15, 730.—It was found necessary to kill a horse suffering from generalized sarcoptic mange. The carcass was used by a class of veterinary students for such purposes as palpation, dissection, operations, etc. The time spent on this work, by each individual, varied from two to four hours.

With the exception of those students who were mere onlookers, or were engaged on the head and neck, parts which had been cured by treatment, all suffered from a most pronounced and continuous itching. The forearms, ankles and calves were affected by the typical papular rash. Each papule was the size of a large pinhead, slightly elevated and of a fiery red color. The hands sometimes escaped the eruption because they were frequently washed with carbolic soap. Some of the students developed secondary lesions on the trunk, thighs, shoulders, and upper arms.

The highly contagious nature of the disease being recognized, treatment was undertaken on the earliest appearance of symptoms. Hot scrubbing baths followed by sulphur ointment applications rapidly cured the cases. Clothing was at once cast off and disinfected. Where this last precaution was neglected reinfection took place.

Sarcoptes scabiei were found on the carcass in abnormally large numbers. It is suggested that these mites migrated from the dead and chilling equine to the human hosts and set up irritation in from two to twenty-four hours.—R. Prosser White.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Do We Neglect the Industrial Skin Sufferer? *R. Prosser White.* Jour. State Med., Feb., 1922, 30, No. 2, 47-59.—In the treatment of dermatitis Dr. White points to the importance of preserving intact the epidermis and the sebaceous glands, which are the natural defences of the skin, while eradicating the causative bacilli—*e.g.*, streptococci and staphylococci. The excess of oily secretion and increased pigmentation in dark colored races enable them to withstand excessive moisture and heat.

The poison which is the cause of so many cases of industrial dermatosis is introduced

through the sudoriparous pores and hair follicles. Thus soot, arsenic, fulminate of mercury, fulminate of silver, mercurous nitrate, thorium, phosphorus, etc., and various bacilli form the *fons et origo mali.*

Four points of supreme importance are emphasized: (1) In handling chemicals, carelessness is a common cause of cutaneous disease. (2) Great care should be taken by the physician to distinguish industrial dermatitis from ordinary dermatitis, as the diagnosis is sometimes difficult. (3) The physician should seek for the cause when cure is delayed; nature will effect a cure if the source of irritation is removed. (4) The user of any commodity should realize his risks and responsibilities.

In this useful but all too brief contribution to industrial dermatology, Dr. White omits many interesting details which he discusses at length in his well-known work on "Occupational Affections of the Skin."—D. A. Coles.

The Extraction of Non-Magnetic Foreign Bodies from the Anterior Chamber of the Eye. *William F. O'Reilly.* Boston Med. and Surg. Jour., March 30, 1922, 186, No. 13, 418-419.—The most common nonmagnetic organic and inorganic foreign bodies finding lodgment in the anterior chamber are: copper, glass, wood, stone, paper, lead, gunpowder, brass, clothing, bone, celluloid, cement, lime and slate. A 2-inch strand of horse hair is looped, sized, moulded and bent to suit the individual case. The usual low non-posterior lip keratotomy is made nearest the foreign body. The hair loop is inserted, passed over the foreign body and gradually drawn out.—Barnett Cohen.

Butyn, a New Synthetic Local Anesthetic: Report Concerning Clinical Use. *Albert E. Bulson, Jr.* Jour. Am. Med. Assn., Feb. 4, 1922, 78, No. 5, 343-345.—"The results of the clinical and experimental use of butyn seem to justify the committee in arriving at the following conclusions:

"1. It is more powerful than cocain, a smaller quantity being required.

"2. It acts more rapidly than cocain.

"3. Its action is more prolonged than that of cocain.

"4. According to our experience to date, butyn in the quantity required is less toxic than cocain.

"5. It produces no drying effect on tissues.

"6. It produces no change in the size of the pupil.

"7. It has no ischemic effect and therefore causes no shrinking of tissues.

"8. It can be boiled without impairing its anesthetic efficiency."—C. K. Drinker.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Safety Engineering as Applied to Oxy-Acetylene Cutting and Welding Apparatus. *F. J. Napolitan.* Safety Engin., Jan., 1922, 43, No. 1, 1-12.—This is a very complete discussion of the many phases of oxyacetylene cutting and welding apparatus. The potential power of such apparatus requires that the most carefully designed devices be applied to it and made as ultimately safe as possible.—R. M. Thomson.

The Development of Safety in the Rubber Industry. *W. H. Larkin, Jr.* Safety Engin., Feb., 1922, 43, No. 2, 44-49.—This paper gives a review of some of the more ordinary things that have been done in recent years for the cause of safety in rubber mills, with a discussion of how safety work is carried on and of the methods used to present ideas of safety to the employees.—R. M. Thomson.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

VOLUME IV SEPTEMBER, 1922 NUMBER 5

CONTENTS

GENERAL

LIST OF PUBLICATIONS ON INDUSTRIAL HYGIENE.—The Industrial Health Section of the International Labour Office intends shortly to begin issuing, at regular intervals, lists containing information regarding publications dealing with industrial hygiene. The International Labour Office therefore requests all scientists and members of the medical profession, who are interested in social and industrial medicine, to be good enough to furnish its Health Section (Industrial Health Section, International Labour Office, Geneva) with detailed bibliographical notes on their recent publications (the author's name, the title of the article, and the date and number of the periodical in which it appeared); and to forward, if possible, a reprint of such articles. In return, the International Labour Office will be pleased to supply its correspondents regularly with its bibliographical lists on industrial hygiene.

VOCATIONAL GUIDANCE. *E. Gauthier.* Internat. Labour Rev., May, 1922, 5, No. 5, 707-722.—The writer, who is Director of the Regional Employment Office of the Ministry of Labor in Paris, has written a brief summary of the development of vocational guidance from its beginning in the United States, and has traced its history in England and the chief countries of the Continent. The need of vocational guidance is discussed at length. The conclusion is reached that whether we regard the problem from the economic, national, or social standpoint, there is great advantage in the vocational selection of boys and girls be

fore they become technically specialized, in order to give to every one of them instruction from which he can draw the greatest benefit, and to which his strength, health, and intelligence are best adapted.—G. E. Partridge.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Poisoning by Shoe Dye. *R. E. Cloud.* Jour. Am. Med. Assn., Jan. 28, 1922, 78, No. 4, 280.—"Nellie M., aged 3 years, had her shoes dyed at 5 o'clock in the afternoon. At 8 the same evening, the mother noticed some blueness of the lips, and at 8.30, when I saw her, her appearance was alarming; the face and hands were very pale, and the lips and finger nails markedly cyanotic. The child was irritable and behaved as if tired. The pulse was 134, heart action regular but agitated, and there was a systolic murmur, heard all over the precordium. The temperature apparently was not elevated, and there were no respiratory or gastro-intestinal symptoms. The eyes, mouth and throat were negative except for cyanosis of the lips and tongue. During examination, the odor from the freshly dyed shoes was very noticeable. With fresh air and rest in bed during the night, the cyanosis gradually cleared up, and the next morning the appearance and condition of the child showed nothing abnormal. When seen again a week later she was perfectly well, and there had been no return of the cyanosis."—C. K. Drinker.

Occupational Poisoning by Arsenobenzenes. *Slosse.* Abstracted as follows from Bull. de l'Acad. roy. de Belgique, 1921, Vol. 1, 416-428, by M. Heidelberger in Chem. Abstr., March 10, 1922, 16, No. 5, 754-755.—"Intoxications with varying manifestations and of varying intensity were observed among the physicians and attendants administering As antisyphilitics. Tests were made by Strzyzowski's modification (*Oesterr. chem. Ztg.*, 1904, No. 4) of the Marsh test. Arsenic was found in the blood in four out of six cases, while normal controls showed none. In 1-g. samples of cleaned and degreased hair all the subjects showed As, which can not be detected in 1 g. of hair from normal persons. In nails 0.05-0.3 g. was sufficient to give a positive test. Hippuric (A) and glucuronic (B) acids in the urine were higher than normal, which is taken to indicate the presence of the benzene part of the arsenobenzenes in the organism. Tests with respired air showed that the substances were not absorbed in this way, but a normal patient in whose socks arsenobenzene was placed showed a rapidly increasing amount of urinary A and B and gave a positive blood test, showing that absorption took place through the skin."

Manganese a Neglected Remedy. *L. J. Boyd.* Abstracted as follows from Jour. Am. Inst. Homeopathy, 1921, Vol. 14, 409-415, by Joseph S. Hepburn in Chem. Abstr., March 10, 1922, 16, No. 5, 755.—"From the pharmacology and toxicology of manganese, the conclusion is drawn that the symptomatology and possible pathology of chronic manganese poisoning is very closely similar to paralysis agitans, progressive lenticular degenerations, and pseudosclerosis. A bibliography is appended."

The Blood Chlorides in Mercuric Chloride Nephritis. *J. A. Killian.* Abstracted as follows from Jour. Lab. and Clin. Med., 1921, Vol. 7, 129-133, by E. R. Long in Chem. Abstr., March 10, 1922, 16, No. 5, 748.—"Two non-fatal cases of $HgCl_2$ poisoning are reported. Both cases presented evidence of severe N retention. As the impairment of renal function due to kidney injury progressed, a diminution of concentration of the chlorides of whole blood was noted. A return to normal of the functional capacity of the kidneys was accompanied by an increase in the blood chlorides."

The Treatment of Acute Phosphorus Poisoning. *H. V. Atkinson.* Abstracted as follows from Jour. Lab. and Clin. Med., Dec.,

1921, 7, No. 3, 148-150, by E. R. Long, in Chem. Abstr., March 20, 1922, 16, No. 6, 965.—"Advantage is taken of the relatively high solubility of phosphorus in oils which are not absorbed. Liquid petrolatum given to a dog one hour after administration *per os* of the fatal dose of phosphorus furnished complete protection against the poison. The petrolatum acts entirely through its physical properties as a non-absorbable, non-irritating cathartic."

Contribution to the Study of the So-Called Fatty Degeneration of the Liver in Inanition and in Phosphorus Poisoning. *I. Salvioli* and *I. Sacchetto.* Il Lavoro, Dec. 31, 1921, 12, No. 8, 229-230.—In a paper read before the Royal Institute of the Sciences and Arts of Veneto, August 21, 1921, Salvioli and Sacchetto reported the results of their histologic and microchemical researches in this field.

1. In the liver of fasting dogs there is a gradual disappearance of those neutral fats which are found in normal animals, and in their place is noted the appearance of droplets of lipoids in marked quantity, especially if the fast is pushed to extremity.

2. The liver of normal guinea-pigs contains certain cells not described by other authors, a little more voluminous than ordinary liver cells and containing droplets of lipoids mingled with a few droplets of neutral fats.

3. These cells with their lipoid content are markedly increased in the liver of fasting guinea-pigs even after a short period of fasting.

4. If dogs, after a long period of fasting, are poisoned with phosphorus, the liver takes on the character of typical fatty degeneration except that in the liver cells, in addition to the neutral fats, a certain quantity of lipoids is also found.

5. In the liver of non-fasting dogs poisoned with phosphorus only neutral fats are found.

6. In guinea-pigs poisoned with phosphorus, whether fasting or not, the liver presents the characters of fatty degeneration, but microscopic examination shows that while all the cells contain a great quantity of neutral fats, there is also an increase of the large cells with lipoid content already described in the liver of the normal guinea-pig.—Alice Hamilton.

The Action of Cyanamid. *E. Hesse.* Abstracted as follows from Ztschr. f. d. ges. exper. Med., 1921, 25, p. 321, in Med. Science, May, 1922, 6, No. 2, 164.—"In connection with cyanamid, which has attained such great importance as an artificial fertilizer, it has been found that persons working with it are attacked by fleeting exanthemata of the head and chest. There is rapid breathing, increased heart action, and low blood-pressure. The attack lasts an hour or two. The curious feature of the attack is that it only comes on when the patient has consumed alcohol in some form.

"It has been thought that alcohol increases the toxic effect of cyanamid, which is by itself considerable. This, however, is not the case.

"Cyanamid is able to energize the action of a number of substances such as chloral hydrate, sodium bromide, theobromin, etc. For example: if a guinea-pig be given a small amount of sodium bromide which is physiologically inactive, followed by a small dose of cyanamid, there is an immediate action as if the animal had been poisoned by a large dose of bromide. In an experiment on a man a dose of cyanamid was taken in the morning, and in the evening, when the experiment had been quite forgotten, the subject took a glass of beer. The typical symptoms came on, the attack lasting six hours. The practical results are obvious, in that all persons working with this fertilizer should abstain from the use of all alcoholic drinks."—M. C. Shorley.

Laws and Regulations Relating to Lead Poisoning. *Gilbert Stone.* London, H. M. Stationery Office, 1922, pp. 247.—This volume which has been prepared for the Governors of the Imperial Mineral Resources Bureau brings together under one cover all legislation aimed at the prevention of industrial lead poisoning. The text of laws and regulations at present in force in different countries forms two-thirds of the book. This part is prefaced by a general analysis in which the scope of the enactments and the objective aimed at in each case are stated. The metal is followed from mining

of its ores, in which, to judge from the scarcity of legislation, there appears to be little risk of poisoning; through the smelting of materials containing lead, which is more or less stringently controlled in many countries; to the manufacture of white lead, which has long been recognized to create risk and to need legal supervision; and, finally, to the use of lead compounds in such varied occupations as the manufacture and use of paints, the pottery industry, the making of electric accumulators, the tinning of metal articles, vitreous enamelling, heading of yarn and file cutting. Regulations controlling the use of bronze powders in printing works are also included; as these powders do not contain lead, however, the reason is not clear.

Only a short chapter is devoted to legislation providing compensation for lead poisoning and it cannot be described as other than unsatisfactory, especially as the author is a barrister; we learn from it nothing as to procedure and only a little as to effect. Perusal of the book indicates that of all countries the code for preventing lead poisoning is most thorough in Great Britain, although even here there is a vacancy with regard to the house painting industry; this vacancy, however, should shortly be filled when action is taken in conformity with the international agreement recently reached at Geneva. On the other hand, the United States appears to have established legislation only in New Jersey and for lead smelting alone; this state of affairs is the more surprising on account of the reports of Dr. Alice Hamilton upon the incidence of lead poisoning in the United States.

The effect of legal enforcement of preventive measures is illustrated by instances taken from Great Britain, where in the white lead industry an annual attack rate of 183 for the period 1900-1904 was reduced to one of seventeen for the period 1915-1919; and in the pottery trade, where an annual attack rate of 357 for the period 1896-1900 was reduced to one of nineteen for the period of 1915-1919. These falls occurred while the number exposed to risk was increasing, owing to trade expansion, and while the tendency to report mild cases was greatly increased, owing to the Workmen's Compensation Act of 1906; thus, of all cases reported between the years 1900-1904, 33.2 per cent. were severe, and 20.8 per cent. were moderate, as contrasted with 18.4 per cent. severe and 32.2 per cent. moderate between the years 1910-1914. This publication will be found of great value by all interested in the legislative control of industrial disease.—E. L. Collis.

Lead Poisoning, with Special Reference to Poisoning from Lead Cosmetics. *M. Barron* and *H. C. Habein.* Abstracted as follows from Am. Jour. Med. Sc., Dec., 1921, 162, No. 6, 833, in Jour. Am. Med. Assn., Feb. 4, 1922, 78, No. 5, 362.—"In the cases reported by Barron and Habein a powder containing pure lead carbonate, ground to an impalpable powder used as a face powder, was responsible for the lead poisoning. It is urged that rigid laws be enacted prohibiting the sale of any compound containing lead for cosmetic purposes."

Lead Poisoning in Making Batteries. *F. Heim*, *A. Agasse-Lafont*, and *A. Feil.* Abstracted as follows from Presse méd., Feb. 1, 1922, 30, No. 9, 92, in Jour. Am Med. Assn., March 25, 1922, 78, No. 12, 927.—"This article is the report of a committee which has been investigating lead poisoning among ninety-six persons employed in making storage batteries. Basophil granulation in the erythrocytes and lead in the urine are the most reliable signs of even incipient lead poisoning."—C. K. Drinker.

Keeping Spray from Workmen. Factory, Feb., 1922, 28, No. 2, 226.—"The Liberty Motor Car Company has recently installed a system for taking care of paint spray. Above the painter's den is placed a hood through which the paint spray is sucked by a motor-driven fan on top. The painter wears goggles as he sprays the black enamel over the automobile frame. The frame moves along the assembly line into big, long ovens where the paint is baked onto the metal."

An illustration is included which gives some idea of the size of the machinery overhead, and how the suction can guard the worker's health.—M. C. Shorley.

DUST HAZARDS AND THEIR EFFECTS

THE SUGAR-TUBE METHOD OF DETERMINING ROCK DUST IN AIR. *A. C. Fieldner, S. H. Katz*, and *E. S. Longfellow*. U. S. Bur. Mines, Tech. Paper No. 278, 1921.—The apparatus, set-up, and procedure are almost identical with that used by the same authors in determining the efficiency of the Palmer dust sampler. (See THIS JOURNAL, 1920-1921, 2, 167.) The efficiency of the sugar filters recommended by the authors was found to increase for fine particles such as tobacco smoke when the sugar was moistened with water or dilute alcohol, and when powdered instead of granulated sugar was used. The general technic in the use of the filters was that conventionally in use. Gravimetric efficiencies were determined by drawing very small quantities of fine silica dust from small dust cloud producers which were weighed before and after the dust had passed to the sugar filters, the decrease in weight being caused by dust entering the sugar filter. The dust collected in the tubes was weighed in the usual manner, blanks being run to determine the water-insoluble matter in the sugar. Gravimetric efficiencies were found to range from 70 to 95 per cent. Optical efficiencies were determined in a Tyndall meter by matching streams of known smoke content against the exhaust from the sugar tubes, and were found to be 23 to 60 per cent. with the standard Bureau of Mines sugar tube. By using greater depths of sugar, by using powdered instead of granulated sugar, and by varying the diameters and hence the filtering surface, the optical efficiencies were markedly increased, ranging as high as 92 per cent. over fifteen-minute periods.

The paper is replete with examples of accomplished ingenuity and technic and, with the authors' earlier paper, forms an important contribution in this field of research.—P. Drinker.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

THE ECZEMA OF MASONS. *Mario Artom*. Il Lavoro, Dec., 1921, 12, No. 8, 225–229.—One of the most common forms of industrial dermatosis is the eczema of masons, affecting, according to Martial, at least one-third of the individuals who work with lime and cement, although few of them come under the eyes of the dermatologist, since the disease is seldom severe. A predisposing cause is the humidity to which the hands of masons, especially plasterers, are continually exposed, and the consequent maceration of the horny layer of the skin, also the frequent abrasions caused by the nature of the work. Lime and the alkaline bases and alkaline earths in nonhydrated form provoke the dermatitis. In the case of cement the author believes that, in addition to potash and soda, aluminum and sulphuric acid favor the formation of dermatitis. The seat of the lesions is always on the hands, especially between the fingers; the palm is almost never affected, even when the eruption covers all the dorsum. Next in order come the forearm, the upper arm, the axilla, the chest in those who work with the chest exposed, and, in one case only, the face. The course may be slow or rapid, and, if the latter, there may be an edematous infiltration. Itching is usually very marked and leads to scratching which may result in suppuration. In some cases there is a formation of indurated pigmented plaques having the appearance of lichenoid eczema.—Alice Hamilton.

TREATMENT OF ACNE ARTIFICIALIS BY ARTIFICIAL SUNLIGHT. *L. Wertheim*. Abstracted as follows from Dermat. Wchnschr., Sept. 24, 1921, 73, 1005, in Arch. Dermat. and Syph., May, 1922, 5, No. 5, 634.—"Two cases of occupational dermatitis (oil acne) are reported by the author. Cures were effected by a few intensive doses of ultraviolet light."

TRAUMATIC DYSCHROMATOPSIA. *Francesco Cioffi*. Il Lavoro, March 31, 1922, 13, No. 3, 65–72.—Cioffi is chief physician of the state railways in Italy. He discusses the occurrence of color-blindness after accidents, as reported by numerous writers, and describes his own observations on railway workers.

Among 8,000 railway workers and applicants for such work whom he examined, he found about 200 color-blind. It is the rule of the railway administration to repeat such

examinations after accidents involving injuries to head or to eyes. Cioffi has never found any alteration of color perception as the result of accidents of this kind. He discusses further the question of including under the compensation law traumatic color-blindness, the existence of which he does not dispute, since an accident of this character would affect the earning powers not only of railway workers and sailors but of painters, decorators, dyers, tile workers, and salesmen of all sorts of goods, as well as makers of clothing.—Alice Hamilton.

Influence of Fatigue on the Perception of Colors. *Rolandi.* Abstracted as follows from Giornale della R. Accademia di Torino, 1921, No. 5-6, in Il Lavoro, Feb. 28, 1922, 13, No. 2, 52.—Rolandi reports interesting results of tests made at a high altitude—at the Mosso Institute on the Col d'Olen—concerning the influence of fatigue on the color perception of seven individuals. At this height a march of four to nine hours over the glaciers is followed by a loss of ability to distinguish colors. Rolandi attributes this effect to fatigue, and states that the more extreme the exhaustion the greater is the extent of colored surface needed to permit of any color perception. The degree of loss varies with different colors, the greatest loss being caused in the perception of yellow, which has the most ample visual field, and losses of decreasing degree being caused in the perception of blue, violet, and red. The loss is least in the perception of green, which of all the colors has the most restricted field.—Alice Hamilton.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Lamp Room Organization and the Upkeep of Safety Lamps. Rep. (British) Miners' Lamps Committee, No. 6.—Early in this report the committee states that it has clear evidence that a poor light increases the risk of accident and disease and adversely affects output. The committee lays great stress on the careless treatment of lamps in the colliery lamp rooms and calls for substantial improvement in lamp room organization. The lamp room should be treated as one of the primary establishments of the colliery.

The recommendations are summarized in twenty-six short paragraphs, of which the most revolutionary are: *(a)* the certification of head lampmen after examination by a board of examiners; *(b)* the instruction of every person newly employed underground by the head lampman or chargeman in the precautions necessary for the safe and efficient use of his safety lamp; *(c)* the issuing of printed instructions relating to the care and use of the particular type of lamp which the new employee is to use.

The report has been well received by the colliery journals, and the Colliery Guardian states, "It is, indeed, probably the most complete and practical document that has emanated from any committee within recent years."—T. L. Llewellyn.

Finger Guards on Presses. *H. J. Scholte.* Zentralbl. f. Gewerbehyg., 1921, 9, No. 12, 294-295.—The author reports on a finger guard for presses, invented by J. D. Filarski, an inspector in Amsterdam. The ordinary foot feeder is replaced by a hand feeder. The left half of the stamper is guarded by a stiff perforated plate, so that it is entirely inaccessible to the worker's left hand. The pieces to be inserted in the press are taken in the left hand, passed to the right, then placed under the stamper. Then the right hand presses down the lever, and while the stamper descends, presses, and goes up again, this hand takes a new piece which the left hand has all ready for it.

The introduction of this device did not slow up production; in fact, the men doing piecework made better wages because they could give more attention to the work when they felt safer. Statistics from one factory showed that during the month before its introduction there were five accidents, but that in nine months after the placing of the guards there were only four, in spite of doubling the number of machines and working two shifts. Moreover, these accidents occurred in persons who were unsuited to this kind of work.

A very clear photograph accompanying the article shows how the device is attached to the machine.—H. G. Noyes.

INVESTIGATING DUST EXPLOSIONS TO PREVENT THEIR RECURRENCE. *D. J. Price.* Nat. Safety News, March, 1922, 5, No. 3, 14-16.—Thirteen explosions in the United States between 1913 and 1921 exacted the following toll: more than 150 lives; more than 200 injuries; more than $15,000,000. Twelve of these explosions occurred between 1916 and 1921. Many industries were affected—not only grain, but the metal, chocolate, and sugar industries.

Disastrous explosions arose from the most trivial causes, such as sparks from a piece of metal, a broken electric bulb, static sparks. In this article Mr. Price describes the work done by the Bureau of Chemistry of the United States Department of Agriculture to help solve this problem.—M. C. Hamblet.

INDUSTRIAL SURGERY

INFECTION IN INDUSTRIAL INJURIES. *F. J. Cotton.* Hosp. Management, Feb., 1922, 13, No. 2, 59-60.—The writer lays emphasis on these factors as causes of still prevalent sepsis in industrial injuries: lack of prompt attention; personal uncleanliness; filthy surroundings; too early use of injured members; indifference; bad judgment (one must consider every case of accidental wound as already infected and so treat it); bad technic (largely due to indifference and poor judgment).

Technic should conform to certain principles: wide exposure of wound surfaces; removal of devitalized tissues; prolonged contact with the chosen mild antiseptic; open drainage or, at the most, a loose suturing of the surface.

The article contains a brief but important discussion of the use of Carrel-Dakin solution. The recommendation is made that hospitals and physicians should in some way be checked up in regard to their results in the field of infection in industrial injuries.—G. E. Partridge.

SPRAIN AND SUBLUXATION OF WRIST. *E. Destot.* Abstracted as follows from Lyon Chir., Sept.-Oct., 1921, 18, No. 5, 659, in Jour. Am. Med. Assn., Jan. 21, 1922, 78, No. 3, 249.—"Destot refers to what he calls scapho-semilunar subluxation, as well as simple sprain, and tells how to recognize and treat both. He prefers immobilization for five or six days with a stiff cardboard splint, leaving the fingers free, rather than massage or rubbing. Compression with cotton aids in resorption of exudation. The hand should slant toward the ulnar side, and be slightly flexed. The subluxation can usually be reduced with the thumb, pushing on the foveola radialis. With recurring subluxation, a laced leather cuff can be worn."—C. K. Drinker.

STIFF FINGERS. *F. J. Cotton* and *E. J. Sawyer.* Abstracted as follows from Boston Med. and Surg. Jour., Feb. 9, 1922, 186, No. 6, 183, in Jour. Am. Med. Assn., March 4, 1922, 78, No. 9, 682.—"Twenty-four hour traction, by miniature winches or by pull of elastic bands, traction exerted in the line of deformity to produce a distraction of joint surfaces, with very gradual change of the line of pull toward flexion or toward extension as the case demands, Cotton and Sawyer claim, will so supplement ordinary physiotherapy methods or so displace them that stiff hands and fingers may possibly come to be rare and come to be regarded as perhaps a reflection on the treatment of the case rather than as the result of the 'Act of God' clause under which surgeons, perhaps, even like the express companies, are a little too much inclined to explain their losses."—C. K. Drinker.

MECHANICS AND TREATMENT OF FRACTURES OF THE FOREARM. *Paul B. Magnuson.* Jour. Am. Med. Assn., March 18, 1922, 78, No. 11, 789-794.—This article is a long and careful discussion of the anatomical and mechanical problems involved in treatment of fractures of the forearm. The author's discussion depends largely upon the illustrations, and the interested reader is referred to the original paper.—C. K. Drinker.

Fracture of Femur in Adults. *A. Charbonnier.* Abstracted as follows from Lyon Chir., Sept.-Oct., 1921, 18, No. 5, 625, in Jour. Am. Med. Assn., Jan. 21, 1922, 78, No. 3, 249.—"Charbonnier analyzes eighty-eight cases of fracture of the femur in Kummer's service, 1916 to 1919, comparing the outcome with different modes of treatment. Nail extension gave excellent results in 84.5 per cent. of the cases in which it was applied, and no serious by-effects were observed in any instance. The Steinmann nail extension method may be counted on, therefore, he says, to give excellent functional results, especially with fracture of the shaft of the femur, and it materially shortens the stay in the hospital. The few drawbacks of the method are amply compensated by the fine results it is capable of giving. Consolidation required from twenty-five to fifty days."—C. K. Drinker.

Studies in Experimental Traumatic Shock. IV. Evidence of Toxic Factor in Wound Shock. *W. B. Cannon.* Abstracted as follows from Arch. Surg., Jan., 1922, 4, No. 1, 1, in Jour. Am. Med. Assn., Jan. 21, 1922, 78, No. 3, 241.—"Aside from the experimental evidence presented by Cannon, which resulted in the building up of a theory of traumatic toxemia as a cause of shock, there are also clinical observations which extended over approximately the same period as the experimental studies, and which, quite independently, led to the same conclusion. The whole question of the nature of shock is discussed at length."—C. K. Drinker.

Experimental Traumatic Shock. V. Critical Level in Falling Blood Pressure. *W. B. Cannon* and *McKeen Cattell.* Abstracted from Arch. Surg., March, 1922, 4, No. 2, 300, in Jour. Am. Med. Assn., April 15, 1922, 78, No. 15, 1158.—"From their experimental results Cannon and Cattell conclude that the critical level, that is, the level at which the blood pressure is no longer capable of maintaining an adequate volume flow to the tissues, and thus serving the normal oxidations of the body, is approximately 80 mm. mercury. Above 80 mm. reduction of the alkali reserve is not likely to appear; but as the pressure falls below this, a reduction will probably occur, which is more marked and develops the more rapidly the lower the pressure. If there has been a loss of blood, the circulation becomes inadequate before the pressure falls to 80 mm. mercury, *i. e.*, the critical level is raised. Experiments also have definitely proved that with an acute lack of oxygen nerve cells abruptly cease to function. The experimental and clinical observations on the effects of prolonged low pressure point to the fact that these sensitive cells may be gradually harmed, if, instead of acute anemia, there is prolonged partial anemia. The authors emphasize the prime importance of early treatment of the low blood pressure of shock. Though the tissues may not suffer until blood pressure has fallen below a critical level of approximately 80 mm. mercury, it is desirable, when the pressure has fallen below this level and has shown no evidence of rising, that it be raised to the normal level of 120 mm. mercury, if possible, in order to provide the most favorable conditions for repair of the damage which has been done."—C. K. Drinker.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Sinistrality and Muscle Coordination in Musicians, Iron Workers, and Others. *C. Quinan.* Abstracted as follows from Arch. Neurol. and Psychiat., March, 1922, 7, No. 3, 352, in Jour. Am. Med. Assn., April 1, 1922, 78, No. 13, 1002.—"A study was made by Quinan of sixteen sinistral patients. Six admitted an unaccountable and capricious tendency to 'bump into things.' One is unable to 'reverse' in waltzing. Of five who had studied instrumental music, two had made fair progress up to a certain point but considered that they had accomplished little for the outlay of time and money. Both are hampered by a defective sense of tempo and find 'sight reading' an embarrassment. Two others abandoned the study of music because they were 'unable to make any headway.'

The remaining one is a talented player but states that she still finds it difficult to 'keep in time.' Of these five musicians, two are left handed and left eyed, one is left handed and right eyed, and two are right handed and left eyed. Five patients are free from motor symptoms. These patients seem to show: (1) that sinistrals are especially prone to various forms of muscle incoordination, and (2) that in some of these persons both the sense of equilibrium and the sense of rhythm are defective. Hoping further to elucidate the subject, a study of sinistrality in skilled manual workers was carried out. Three series of 100 men each, classified as (1) professional musicians, (2) machinists, and (3) male inmates of a public relief home, were also examined. Four per cent. of the machinists proved to be left handed and an additional 4 per cent. had sinistral peculiarities. In striking 8 per cent. of left handedness was found among the musicians while the lesser forms of sinistrality mounted to 24 per cent. It was evident from this research that left handedness and sinistrality usually are indicative of the psychopathic constitution."—C. K. Drinker.

Increase of Globulins in Spinal Fluid. *H. Baar.* Abstracted as follows from Wien. klin. Wchnschr., Dec. 22, 1921, 34, No. 51, 614, in Jour. Am. Med. Assn., April 1, 1922, 78, No. 13, 1012.—"Baar made examinations in a number of organic and functional affections of the nervous system in childhood with respect to the behavior of globulins in the cerebrospinal fluid. He found an increase of the globulin content in many different cases. In uremic and eclamptic attacks, and especially in repeated spasmophilic convulsions, the globulin content of the cerebrospinal fluid attains the same degree as in tuberculous meningitis. In convulsions due to disturbances of functioning, the globulin content of the spinal fluid is greatest during the convulsive stage and drops after the convulsions cease, whereas in the case of tuberculous meningitis the globulin content increases from the beginning of the irritation stage until the fatal outcome. In a number of organic affections of the central nervous system which are of moment in the differential diagnosis of tuberculous meningitis, there was just as marked an increase in the globulin content as in the latter disease. However, the Pándy reaction, if conservatively interpreted, will render valuable service in differentiating tuberculous meningitis from clinically similar functional affections; particularly, a negative reaction is of importance. For the differential diagnosis as against organic diseases presenting a similar clinical picture to tuberculous meningitis, the value of the phenol reaction is only limited, and, in case of a positive reaction, only the continuous increase of the intensity of the reaction is significant."—C. K. Drinker.

Diagnostic Value of Determining Vital Capacity of Lungs of Children. *May G. Wilson* and *Dayton J. Edwards.* Jour. Am. Med. Assn., April 15, 1922, 78, No. 15, 1107-1110.—The author concludes as follows:

"1. Vital capacity measurements should be recorded on routine physical examination.

"2. The determination of vital capacity of the lungs in children is indicated as a practical and valuable diagnostic measure."—C. K. Drinker.

Relation between Fatigue and Susceptibility of Rats toward a Toxin and an Infection. *E. H. Oppenheimer* and *R. J. Spaeth.* Abstracted as follows from Am. Jour. Hyg., Jan., 1922, 2, No. 1, 51, in Jour. Am. Med. Assn., Feb. 25, 1922, 78, No. 8, 611.—"Oppenheimer and Spaeth found that fatigue, artificially induced in white and hooded rats by forcing them to run in motor driven drums, apparently tends slightly to increase their resistance to subcutaneous injections of tetanus toxin. This occurs whether fatigue precedes or follows the injection of the toxin. These results contradict the popular belief that a fatigued individual is more susceptible to disease (tetanus toxin and pneumococcus infection) than a nonfatigued individual."—C. K. Drinker.

Influence of Fatigue on Certain Optic Phenomena. *E. H. Sanders.* Nederl. Tijdschr. v. Geneesk., Oct. 8, 1921, 2, No. 15, 1820-1836.—This article presents a technical discussion of the physiology of visual fatigue. —N. C. Foot.

HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

ELECTRIC ACCIDENTS. *C. W. G. Mieremet.* Abstracted as follows from Nederl. Tijdschr. v. Geneesk., Nov. 26, 1921, 2, No. 22, 2678, in Jour. Am. Med. Assn., March 18, 1922, 78, No. 11, 855.—"Mieremet was impressed with the similarity between the local microscopic findings in burns from a strong electric current and burns from the action of fire. But the macroscopic picture may differ decidedly; only with the electric injury—and not always then—do we find the hard white patches resembling cartilage or stearin. These patches induced in rabbits were cast off after a few days, seventeen at most. This occurs also after clinical electric accidents, these injuries behaving differently in this respect from ordinary burns and other wounds."—C. K. Drinker.

LOW-VOLTAGE ELECTRICAL HAZARDS. *S. E. Whiting.* Safety Engin., Feb., 1922, 43, No. 2, 63-66.—This article gives a few cases of fatalities due to low-voltage circuits, that is, from 110 to 550 volts. The author emphasizes the need of proper grounding of starting boxes, motor frames, and switch cases. In damp locations, or in places where one's body can be well grounded, it is in the interest of safety to use reinforced cord, wooden handles and porcelain sockets on all extension cords.—R. M. Thomson.

THE CAUSE OF DEATH IN ELECTRICAL SHOCK. Brit. Med. Jour., March 25, 1922, No. 3195, 478-480. — This is a report of a discussion in the electrotherapeutic section of the Royal Society of Medicine, which was contributed to by Dr. T. M. Legge, Mr. Scott Ram, Mr. G. Levy, Dr. B. Spilsbury, and Prof. J. MacWilliam.

The majority of deaths due to electricity occur in factories, but some, owing to the carelessness shown in the construction of electric apparatus, occur among the ordinary public. Many interesting facts were reported, including the greater tendency of shock due to low pressure alternating currents (250 volts or less) to be fatal, than that due to currents of higher voltage.

Two views were put forward as to the cause of death: one, that of Jellinek, who holds that immediately after shock death is apparent rather than real, owing to the temporary paralysis of the respiratory center, and that recovery depends upon artificial respiration; the other, that of Boruttau, who holds that in the majority of cases death is real. In such cases the result may be due to ventricular fibrillation which, in animals at any rate, may pass off spontaneously and is not assisted by artificial respiration. The possibility of both paralysis of respiration and ventricular fibrillation being present at once was considered not unlikely.

The curious fact was stated that recoveries seem more frequent when the victim suffered from countershock, such as falling from a height after exposure to the current. Definite agreement as to the exact condition following shock was not arrived at, but as a measure of first-aid treatment, the practice of applying artificial respiration for an hour or more was recommended for adoption.—E. L. Collis.

HEAT, COLD AND HUMIDITY

VASOCONSTRICTION FROM WARMTH STIMULATION. *E. G. Martin* and *L. A. Jacoby.* Abstracted as follows from Am. Jour. Physiol., Feb., 1922, 59, No. 1, 394, in Jour. Am. Med. Assn., April 1, 1922, 78, No. 13, 1000.—"In nine out of eleven experiments made by Martin and Jacoby immersion of the lower part of the human body in water at about 45° C. was followed in seven seconds, on the average, by a drop in temperature of the skin of the small of the back averaging slightly less than 0.2° C. Accompanying this drop in temperature were well marked 'gooseflesh-ing' and sensation of chilliness. Martin and Jacoby interpret these findings as evidence that a large volume of nervous discharge, due to stimulation of a great many receptors for warmth, elicits, typically, reflex vaso-

constriction. This interpretation is opposed to the view that vasodilatation is the specific reflex response to stimulation of the end organs for warmth."—C. K. Drinker.

Nephritis from Chilling. *F. Gaisböck.* Abstracted as follows from Wien. Arch. f. inn. Med., Nov. 15, 1921, 3, No. 1-2, 1, in Jour. Am. Med. Assn., April 8, 1922, 78, No. 14, 1094.—"Gaisböck in experimenting on rabbits found that acute inflammation of the kidney could be induced by direct chilling of the organ. Chilling to 9 or 10 C. induced nephritis of the glomerular-tubular type, while with chilling to 3 or 4 C. there were degenerative changes as well as inflammatory. The changes, however, seemed to be able to heal in time. Severing the splanchnic nerve or decapsulation beforehand did not seem to modify conditions, except that the latter was followed by proliferation of connective tissue, a traumatic nephritis. Inoculation with streptococci at the time of the chilling entailed an acute interstitial nephritis with changes in the glomeruli and entire parenchyma."—C. K. Drinker.

The Humidity and Insensible Perspiration. *O. Moog.* Abstracted as follows from Deutsch. Arch. f. klin. Med., Jan. 24, 1922, 138, No. 3-4, 181, in Jour. Am. Med. Assn., April 8, 1922, 78, No. 14, 1092.—"Moog was surprised to find in tests of five persons that the insensible perspiration continued the same regardless of the greater or less humidity of the air. This could not occur if the insensible perspiration were merely an ordinary evaporation process. If this were the case, the amount of water cast off through the skin would diminish with increasing humidity, while the reverse of this was the rule in his tests."—C. K. Drinker.

WOMEN AND CHILDREN IN INDUSTRY

Iowa Women in Industry. U. S. Dept. Labor, Women's Bur., Bull. No. 19, 1922, pp. 73.—During October, November, and December, 1920, an investigation was made of 223 firms in twenty-one cities, and data were gathered in regard to 10,411 women and 11,718 men employed in manufacturing plants, stores, restaurants, hotels, and laundries. The laws of Iowa do not require the keeping of employment records, and it was found that of the 223 firms (six not reporting), only fifty-four kept employment records of any kind.

There are no laws regarding the number of hours that a wage-earning woman may work. It was found that 2.8 per cent. of the women workers were working sixty hours a week, and in forty-four cases there was a week of eighty-four hours. Only 1.9 per cent. had a day shorter than eight hours. Many women worked overtime.

A study of the lunch periods in 193 establishments (restaurants not included), showed that sixty-seven had a thirty-minute period, and ninety-nine a sixty-minute period. Conditions in the restaurant business were especially poor, because of excessive hours of work, as a result of which the turnover is tremendous. Many women working in these places have home duties which they must fulfill in the scant hours left them from work.

More than one-half of the plants had no lunch rooms. Only seventy-four had any provision for resting, and regular rest periods were provided for in only a few establishments. Of the 223 plants, thirty-nine had no cloakrooms, and in 125 there was only cold water. Common towels were provided in 145 plants. There is a law requiring that a sufficient supply of water suitable for drinking purposes shall be provided. The facilities, in reality, vary all the way from the most sanitary to no provision at all. The common drinking cup was found in ninety-two establishments.

There is no law regulating lighting in Iowa industries, but the plants visited were found on the whole to use sufficient natural and artificial light. Iowa has no complete code regulating working conditions for women. In some establishments cleaning has been systematized, and janitor service and matron service were found to be excellent. In other establishments, however, conditions were poor, and in some instances the workers were made to act as the janitor force. In button factories it was found that nine of the ten plants were cleaned by the women

workers, although most of these women were on piecework.

Part II of the report deals with industrial opportunities and training. "Only five per cent. of the firms employed special people to devote their time to the instruction of workers and beginners." Among the industries other than mercantile, one printing firm had a personnel director, and there were several concerns having trade instructors. In 8 per cent. of the plants there were persons whose principal duty was to instruct others, although they were hired as operators.

The report ends with an account of trade extension work by the state. There are three maps and eight tables, and an appendix containing additional tabulated data.—G. E. Partridge.

The International Protection of Women Workers. Studies and Reports, Internat. Labour Office, Oct. 15, 1921, Series 1, No. 1. —The article contains a useful sketch of the history of protection of women workers up to the time of the Third International Labour Conference, which was to be held at Geneva in October, 1921.

The program of the Third Conference, as far as women's employment is concerned, is given. There were to be considered: the question of the adaptation to agriculture of the decisions made at Washington; special protective measures for agricultural laborers in connection with technical education, housing and sleeping accommodation, and the guarantee of right of association and combination; protection against accident, sickness, invalidity and old age; weekly rest days; the protection of women before and after childbirth; the night work of women in agriculture.

Questionnaires sent to the governments have brought information that indicates difficulty in applying maternity legislation to agriculture because of the heavy financial burden involved in its extension. Of the sixteen countries making replies up to the time of the report, only two—France and Spain—declared unreservedly in favor of the plan. A draft recommendation was, however, prepared for the Conference.

With regard to night work in agriculture it was found that it is practically non-existent in the case of women workers in agriculture, and the majority of the governments have signified that they are not in favor of applying to agriculture the Washington Convention concerning night work.

Several governments have recognized the need of providing adequate consecutive hours of rest for women in agriculture, so that they need not be called upon to attend cattle in the early morning after doing housework late at night. A draft recommendation to that effect was therefore prepared, asking for a rest period of not less than nine consecutive hours.

Most of the draft conventions submitted to the Conference ought, in the view of the governing body of the International Labour Organization, to apply equally to women and to men. The principal importance of the Conference lies in the proposal to place men and women on a footing of almost complete equality in all protective measures contemplated.—G. E. Partridge.

The Need for Special Health Protection of Employed Adolescents. *H. H. Mitchell.* Am. Jour. Pub. Health, Nov., 1921, 11, No. 11, 973.—At the present time we have very little knowledge of the physical effects of industry upon adolescents and, although we have reason to believe that this group needs special health protection, very little has been done. Now, however, with the development of the compulsory continuation school, there comes an opportunity to inaugurate a constructive health service for these young people.

"It seems safe to assume from our present knowledge that the age period in which from 20 to 75 per cent. of our children leave school to go to work is characterized by such tremendous changes in physiology and morphology as to make very special demands upon the vitality of the child." The period is a time of crisis even under the best of conditions, and calls for protection from strain and any hazards likely to influence health and normal physical development.

Dr. Teleky of Vienna concludes that the sickness insurance funds give evidence that the morbidity of young workers is extremely high and that the frequency of sickness is greatest, not at the age of 14 soon after entrance into industry, but later. Von Pirquet comments on the marked rise in the

tuberculosis death rate occurring between 15 and 20 years of age as due to gainful occupations, overwork and bad food.

Statistics of the United States Bureau of Labor relating to conditions in Fall River indicate that conditions in the cotton mills are conducive to death from tuberculosis. "The hazard of young female operatives from eclampsia was very marked." The general death rate of "operative females was thirty-three per cent. higher than that of non-operative females."

In the printing trades also there is a higher death rate among the young workers than in the general population of the same ages. Hoffman's figures for England and Wales show a death rate for printers of 3.19 per 1,000 for ages 15 to 19 years, and 2.44 per 1,000 for all occupied males. DeVooys gives the rates for tuberculosis in Holland for the years 1896-1900, for the ages 12 to 17 years, as 118 per 100,000 for printers and 54 for all occupied males at those ages. For the age group 18 to 22 years, the rate was 625 per 100,000 for printers, and 239 for all occupied males.

Hayhurst's statistics for Ohio lead to the inference that in the United States there is a relatively small number of printers under 20 years of age, but these should have better health protection than at present.

The next logical step should be to test the efficiency of the single examination as a method of health protection. The need for re-examinations could be tested by examination of children in the continuation schools; and we could in this way obtain evidence of the relation of various kinds of employment to the health of the young worker.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Report of the Advisory Committee on Atmospheric Pollution for the Year Ending March 31, 1921. H. M. Stationery Office. 1922.—The extent to which atmospheric pollution is dependent upon industrialism is brought out. Thus, the deposit carried down by rain amounted in metric tons per square kilometer in industrial towns, for Rochdale to 24.9, for Birmingham to 21.2, for Newcastle-on-Tyne to 17.4, and for Liverpool to 17.2; while it amounted in more favorably situated localities, for Victoria Park (London) to 7.9, for Southport (Woodvale, Moss) to 5.5, and for Rothampstead to 4.2. These amounts represent deposits washed down by rain; hence they are greater in those months of the year when the rainfall is heaviest. In the summer months at Rochdale with a rainfall of 127 millimeters the deposit was 33 metric tons, and in the winter months with a rainfall of 76 millimeters the deposit was 16.7.

From a health point of view the material deposited is of interest only because it represents what was previously suspended in the atmosphere. Observations on impurity suspended have been made in London and diagrams are given showing how high this rises on foggy days. An attempt is recorded to ascertain the effect of suspended impurity upon health. But up to the present no valuable results have been obtained—probably owing to the shortness of time the records of impurities have been kept.

An interesting reference is made to a method of estimating dust in expired air. Here Dr. J. S. Owens sees reason for holding that ordinary atmospheric dust does, in fact, gain access to alveolar air and that only 30 per cent. of the dust inhaled is removed by the air passages. Further work in this direction will be followed with great interest.—E. L. Collis.

Vacuum Cleaning Applied to Industrial Plants. *C. L. Hubbard.* Factory, March, 1922, 28, No. 3, 285-288.—Vacuum cleaning has recently extended its usefulness to the industries, both in special processes and in general cleaning. This article describes, with diagrams, the fundamental construction of vacuum apparatus and different types of separator adapted to different uses. Estimates are given of the number of sweepers required for various extents of floor space, and the principles, by which the size

of hose and pipe lines is governed, are stated. Suggestions are made in regard to the selection of tools.—G. E. Partridge.

WASHING FACTORY WINDOWS. *T. S. Haviland.* Factory, March, 1922, 28, No. 3, 302. —A great amount of money is spent annually in the washing of factory windows, since usually on large buildings it is necessary to erect staging or other temporary means. The power plant of the Cleveland Water Works has installed a permanent tram rail and car system for washing windows. The rail and fixtures are of simple design and standardized so that any mechanic can lay out, order and install a section or a complete system. There are several advantages, chief among them the entire elimination of the element of danger. With the use of the system 4,600 windows are cleaned by three men in twelve days, at about one-fifth of the ordinary cost.—G. E. Partridge.

INDUSTRIAL WASTES IN RELATION TO WATER SUPPLIES. *W. Donaldson.* Am. Jour. Pub. Health, May, 1922, 12, No. 5, 420-421. —An industrial pollution which places upon water works an unusual burden or difficulty in the way of purification must assume the aspect of a public health problem.

This paper discusses briefly some of the common problems due to industrial wastes. Petroleum wastes, though presumably of no direct hygienic significance to water consumers, impart a flavor or taste sufficient to cause many people to forsake the safe public supply and resort to bottled water of doubtful purity or to local springs and wells potentially or actually dangerous. Producing a similar effect may be mentioned harmless algal infestation, salt wastes from oil well operation, and chlorination odors and tastes produced by chlorine in waters polluted with phenols from waste from gas houses, by-product coke works, or producer gas plants.

Of more importance are the industrial wastes which interfere with proper operation of purification plants, either by impairing efficiency or by imposing an intermittent or irregular load. In this group are mentioned oily, fibrous or pulpy matters. Wastes acting as protective colloids making difficult or uncertain the coagulation with aluminum or iron, include tannery liquors and dye wastes.

Lastly are mentioned soluble inorganic substances, such as lead, zinc and arsenic, which make their presence known only through cumulative effect on public health. —H. F. Smyth.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

BETTER WORK AND MORE WORK PER MAN THROUGH BETTER SIGHT. *E. LeR. Ryer* and *W. B. Fisher.* Indust. Management, Feb., 1922, 63, No. 2, 111-117.—This is an account of a detailed examination of the eyes of 415 employees of the General Optical Company.

Of 830 eyes examined, only 120 were passed as absolutely normal, and more than 200 had defects of such a degree as to call for immediate correction. There were found 127 cases of ocular disease, of which 109 were internal and discernible only by use of the ophthalmoscope.

Of three plans of conducting eye examinations and making corrections, one that comprises thorough examination up to the point of recognizing defects, the employee then to be advised to consult an optical specialist of his own choice, is recommended for industrial concerns not closely connected with the optical industry.

The examination room should be centrally located. The equipment will, of course, vary according to the size of the plant, since when the number to be examined is not large the specialist engaged will be depended upon to bring his own instruments. Preliminary investigation, such as testing for visual acuity and color blindness, taking case histories, etc., should be done by the welfare or personnel department. The specialist should visit each department before examining the workers in order to know the conditions under which the eyes are used.

The value of such examinations as are proposed is great. As a result, the comfort and efficiency of the worker may be increased; production is improved; the quality of the work is changed for the better; data are obtained that may be invaluable in accident cases. Costly processes of selection by trial are avoided.

The suggestion is made that the function of stereopsis should be given more consideration in regard to such employments as those of chauffeur, engineer, motorman, and machinist, in order to detect persons who misjudge distance, and who for that reason are likely to cause accidents.

Information about equipment for industrial examinations and advice as to procedure and record, of interest to the specialist, may be found in the article.—G. E. Partridge.

Defective Vision among Industrial Workers. *Carey P. McCord* and *Donald J. Lyle*. Jour. Am. Med. Assn., Feb. 25, 1922. 78, No. 8, 606-607.—The authors examined sixty-two workers in a textile plant where good eyesight was necessary to obtain the best manufacturing results. Eighty per cent. were women and the average age of the group was 39 years. The chief eye findings were:

"1. Of the sixty-two persons examined, fifteen persons (24 per cent.) possessed vision of 20/20 or better.

"2. The average vision (uncorrected) for the entire plant's personnel (sixty-two) was 20/61.

"3. The average vision of all persons (forty-five) working without glasses was 20/34.

"4. The average vision for persons (seventeen) wearing glasses at work was 20/36.

"5. Eleven persons wearing glasses only for reading purposes at home were engaged at close work with an average vision of 20/55.

"6. Twenty-two per cent. of persons working without glasses exhibited only 1/2 vision or less in one or both eyes.

"7. Thirty-seven per cent. of all workers not wearing glasses would be distinctly benefited through the wearing of suitable glasses.

"8. In those persons (seventeen) already wearing glasses, only four instances were noted wherein the defect was fully corrected. In 33 per cent. of instances, the vision was not at all improved by the glasses that had been supplied to them."

The poor vision in these individuals is a disadvantage to both employee and employer and, coupled with other experiences in industrial medicine, causes the authors to make the following recommendations:

"1. Illuminometer measurements of the light provided for the several types of work in the factory; the provision and maintenance of that quantity of light optimal for the individual job; the elimination of glare.

"2. The suitable testing of visual acuity of applicants for work, and of all employees at yearly intervals.

"3. The referring of all persons exhibiting defects of 20/30 or greater to reliable ophthalmologists for corrections.

"4. Selected job placement for all persons having defects of 20/25 or greater, for whom correction is not feasible or obtainable.

"5. Payments for services of specialist and optician to be made by the factory management, arrangements being made with employee to deduct small weekly repayments from earnings. This procedure insures prompt remedying of the defect, is usually entirely satisfactory to the employee, and avoids services from incompetent sources."
—C. K. Drinker.

Medical Service of Chicago "L" Roads. *H. E. Fisher*, Hosp. Management, Feb., 1922, 13, No. 2, 56.—The medical department of the Chicago Elevated Railroad serves approximately 7,500 employees. It began with physical examination of applicants for employment, but has extended its activities to include periodical examination of all employees, and the treatment of injuries incurred in the course of duty. A high standard of physical health is set, and all employees (except general office employment and women ticket agents) are examined every two years. The names of those found to have defects are recorded on observation cards and these men are examined at intervals between the regular examinations.

A sanitary inspection is made approximately every four months under the direction of the medical department, in order to determine the condition of all the properties, and a report is made accordingly to the heads of departments.

A first-aid system with about 200 stations is maintained, each station being under the charge of an employee who has received instruction from the medical department. This first-aid instruction is supplemented by health talks through a monthly publication, and there is a first-aid drill team.

Suggestions are made as to what constitutes an effective first-aid service, and the article contains also a list of the contents of the first-aid boxes in use on the Chicago Elevated Roads.

The writer thinks that "with first-aid work properly organized and maintained, the opinion of the medical profession in the past, that the teaching of laymen to do first-aid work was of little value, will be changed and objections overcome." In transportation work first-aid service is indispensable.—G. E. Partridge.

INDUSTRIAL INVESTIGATIONS AND SURVEYS

A Useful Factory Inspection Form. U. S. Pub. Health Ser., Pub. Health Rep., Jan. 6, 1922, 37, No. 1, 10-12.—The inspection form presented is one that was used in some studies in munitions plants during the war. The form is printed on a heavy card $8\frac{1}{2}$ by 11 inches. The front contains an outline for a report of the conditions under which the worker operates: type of building, ventilation, illumination, general conditions, safety hazards, fumes and gases, specific poisons, exposure to heat and cold, fatigue, excessive noise. The back of the card has a printed outline for a rough job analysis in which are to be entered processes, materials, products, degree of skill required, hazards, rest period, method of payment, etc.—G. E. Partridge.

INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

Welfare Work in Bombay Cotton Mills. *N. M. Josshi.* Jour. Indian Indust. and Labour, Feb., 1921.—This article is one of great interest; it tells of the inauguration by the Social Service League some three years ago of welfare work in India, of what is being attempted, and of difficulties encountered. Eight years ago it would have applied in all that it contains to England or America; indeed, it still applies to much of our industrial world. India is only just becoming industrial, and, if welfare work develops as industries develop, she may escape from or solve many difficult problems.

Special difficulties are reported: the insidious money lender or a head-jobber, who is in league with professional money lenders, has to be met by co-operative credit societies; the education of half-time workers (and also adults) has to be undertaken in a country where there is no compulsory education, and where reading rooms and libraries would otherwise be superfluous; crèches are particularly needed for the babies of working mothers. Alcoholism is reported to be increasing with the spread of industrialism, just as it did in England in the eighteenth century, and to call for control. On the other hand, the establishment of dispensaries attended by qualified doctors, of home visitation of the sick, of an eye and dental clinic for half-timers, of outdoor recreation schemes, of public lectures, and of hostel accommodation are reminiscent of our own activities. And so, indeed, are the very phrases used by the author:

"Welfare work is popularly associated with recreation, dining halls, and such other things which, really speaking, form but a fraction of the work which requires to be done for the benefit of workmen in an industry. Recreation and facilities in such other matters will help very little to improve the *morale* of the workpeople if they are ill-paid, ill-fed, and ill-housed . . . Superficially, cheap labour is very costly in the long run, and the aim must be to make workpeople healthier, happier and more intelligent,

and more self-respecting. A really self-respecting workman will always be a safer person to deal with than one who is wanting in this quality. Particularly in welfare work it is necessary to preserve and promote self-respect, for if that work is carried on in a patronizing spirit and is considered as only a sop, it is likely to lose all its value, and labour will rightly resent it." In truth the spirit of welfare and health work is steadily spreading throughout the world.—E. L. Collis.

"We Didn't Have Space for a Lunchroom." *R. Desing.* Factory, March, 1922, 28, No. 3, 300-302.—This article describes a cafeteria arrangement by which each department of a factory has its own canteen. Lack of space for a restaurant led to this experiment in a plant employing 5,500 men and women. Cafeterias were established on nearly every floor of the factory buildings, supplying the noon meal to 87 per cent. of the employees.

As a study in system this report deserves careful consideration by anyone having a similar problem, on account of both the limitation of space and the location of the plant, remote from the homes of the workers. The main inducement in attempting the experiment in this instance was the bad effect upon the workers of eating unsuitable lunches and the consequent loss of time and efficiency in work.—G. E. Partridge.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS; WORKMEN'S COMPENSATION AND INSURANCE

Typhoid Fever Held Compensable under Workmen's Compensation Act. U. S. Pub. Health Ser., Pub. Health Rep., March 10, 1922, 37, No. 10, 538.—"The Appellate Court of Indiana has decided that typhoid fever contracted by an employee through drinking impure water furnished by the employer, is an 'injury' by 'accident arising out of and in the course of the employment,' under the Workmen's Compensation Act, and as such is compensable."—Barnett Cohen.

Employee Insurance. Abstracted from System (British), Dec., 1921, in Factory, March, 1922, 28, No. 3, 326.—This is a brief summary of the status of employee insurance as now established by various acts of the British Parliament. The protection granted to the employer constitutes an indemnity. The onus of proof that an accident has happened devolves upon the claimant. It is unnecessary to prove negligence on the part of the employer, and a workman injured through his own stupidity or carelessness is entitled to compensation, if the accident has arisen "out of and in consequence of the employment." Various specified diseases come under the category of accidents. There is no limit of period during which weekly compensation is payable, but after six months the employer has the right to commute future compensation by the payment of an amount sufficient to purchase an annuity with the post office equivalent to three-fourths of the compensation payable. The employee's right holds good against the legal personal representative of a deceased employer.—G. E. Partridge.

REHABILITATION OF DISABLED EMPLOYEES

Occupational Therapy. *J. W. Brannan.* Am. Jour. Pub. Health, May, 1922, 12, No. 5, 367-376.—This paper is a brief, profusely illustrated account of occupational therapy as recently introduced into the wards of Bellevue Hospital. This work should be under the direction of the medical staff and should receive its enthusiastic support. The needs and capabilities of each individual patient should be carefully studied and the kind and amount of work prescribed by the physician. Complete records should be kept with daily notes of progress. The interest and support of the superintendent are essential

as well as the sympathy and co-operation of nurses and social service workers. The success of occupational therapy is largely dependent upon the tact and good judgment and thorough training of the teachers. It is suggested that the medical colleges be asked to add to their courses in therapeutics "The Science of Healing by Occupation."

Among the good results of occupational therapy are the following: Patients who have been given some form of interesting occupation are happier and recover more rapidly, and are in a better condition to resume work; the period of hospitalization is lessened by as much as one-third in many cases; a large number of psychopathic patients recover who formerly would have been committed to hospitals for the insane; occupational education has been of great therapeutic value to neurological ward patients and has vastly improved their morale and, therefore, their health; surgical patients have function restored to stiffened joints and flabby muscles; the entire aspect of wards is greatly changed for the better.—H. F. Smyth.

Safety. Abstracted as follows from Iron Age, April 13, 1922, in Factory, June, 1922, 28, No. 6, 688.—"As a direct result of the world-wide experiments in rehabilitation of men injured in war, America has now a hospital dedicated solely to the care of industrial diseases and accidents and the restoration of industrial casualties to active useful life again. It is the Reconstruction Hospital, at 100th Street and Central Park West, New York. It now enters upon a national career, prepared to offer a unique service to all industry in general.

"It is a new idea to have a hospital where men suffering from any of the many casualties of industry may receive the benefits of an intensive study of their cases by surgeons specializing in all the after-care of the patient until he is fit to earn a livelihood.

"Yet, in the brief life of the present hospital, men have been sent from all over the country to take advantage of its unusual treatment, and many suffering from seemingly incurable physical ailments and distortions have been returned to their place in useful industrial life again."—M. C. Shorley.

From the Accident Back to the Job. *Hilda B. Goodman.* Hosp. Management, April, 1922, 13, No. 4, 57.—Because, during the war, the medical profession and the public saw the ill effects of having wounded soldiers lying in hospitals and at home without definite work to occupy their spare hours, sums of money have been spent on occupational therapy in military hospitals. The need is as great in industrial medicine, but in this field the work is largely for the future. The long convalescence of the injured man favors the development of indolence of mind, with the result that many cripples are not ambitious for work, even when work has been made possible by surgical skill. Both in the hospital and after going home, the injured man is not being subjected to the proper influences and is not likely to be suitably occupied.

The curative workshop becomes a need. On the plan of occupational therapy, interest is aroused as soon as possible. A man goes to the workshop when able, and his affiliations with the shop are maintained after going home. At the workshop he receives massage, he exercises and measures his progress there on apparatus, he engages in some occupation, and he receives a commission for the sale of the articles which he has made. Means of recreation, such as books and games, are provided.

An ideal curative workshop for industrial workers should be near manufacturing districts and be provided with plenty of room and air. It should open and close with the factories. It should have a convalescent ward, with a doctor and nurse in attendance.—G. E. Partridge.

ABSTRACT OF THE LITERATURE

OF

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CONTENTS

GENERAL

FACTORY INSPECTION IN SOUTH AUSTRALIA IN 1920. Abstracted from Report of Chief Inspect. Factories for Year Ended Dec. 31, 1920, in Internat. Labour Rev., March, 1922, 5, No. 3, 514.—The factory inspection office of the South Australian government administers the Factories Acts, the Early Closing Acts, the Apprentices' Technical Education Act, the Lifts Regulation Act, the Employees' Registry Offices Act and several others.

The forty-eight-hour week was generally in force in 1920, but there was a tendency to change it for a forty-four-hour week. Overtime work was less frequent than in the preceding year. Wages increased during the year in all the occupations regulated by wages boards.

The accident record for the year is reported, and there is noticed marked antipathy on the part of the workers to the use of guards for machinery. Under the Industrial Code, occupiers of factories will henceforth be responsible for seeing that guards are furnished and kept in place.—G. E. Partridge.

FACTORY INSPECTION IN NORWAY IN 1920. Abstracted from official report, in Internat. Labour Rev., March, 1922, 5, No. 3, 509-511.—The administration of the labor inspection laws in Norway is in the control of two bodies: the inspection department, and an advisory labor council—both parts of the Department of Social Affairs. The Labor Council deals with such matters as applications for exemption from the eight-hour regulations, and for reduction of hours in special cases.

Special regulations were issued during the year in regard to hygiene and sanitation in

cellulose, explosive, match and electrochemical factories, lithographic establishments, and metal grinding. Accidents reported during the year amounted to 2.7 per cent. of all persons employed.

The report of the chief woman inspector contains several illustrations of departments of model factories and examples of effective guards and working clothes. Statistics are given in regard to the activities of the inspection department, etc.—G. E. Partridge.

Rise of Factory Labor in India. *R. K. Das.* U. S. Bur. Labor Statis., Month. Labor Rev., March, 1922, 14, No. 3, 7-27.—The rise of modern industrialism in India has centered about the development of two great industries, the manufacture of cotton and of jute. Three classes—the cultivators of land, the village servants, and the artisans or craftsmen—have been drawn upon as industrial workers. Figures for 1917-1918 (as given in "Statistics of British India") show a total industrial operative force of 1,238,238, about half of which is employed in the textile industries (this number including those engaged in the transport industries). Bombay is the center of the cotton industry, and Bengal of the jute industry.

At the beginning of the Indian factory system, the time of work extended from sunrise to sunset. In 1911 the hours of work of adult males were limited to twelve in one day, and in February, 1921, a resolution was passed in the Indian legislature ratifying the draft convention of the International Labor Conference held at Washington, D. C., in 1919, which reduced the working hours in Indian factories to sixty hours a week for both men and women.

The factory act of 1911 made special provisions regulating the hours of child workers. Children were required to produce certificates of age and physical fitness before they could be employed, and could be admitted to full-time employment only at 15 years of age. Their working hours were fixed at seven, with one-half hour of rest for every six hours of continuous work, but for textile factories the hours were limited to six in any one day, with no provision for a rest period.

The common time measure for computing wages in the factories was the month. The average monthly wages paid in a Bombay cotton mill in January, 1919, varied according to the occupation from 8 rupees to 75 rupees, jobbers in the weaving department earning the highest wages—from 45 to 75 rupees (the rupee at par is 48.66 cents). Tables show the movement of wages in a variety of industries from about 1890 to 1920; in rare cases the wages have been trebled, but an increase of from 50 to 100 per cent. is commonly shown. The cotton mills, however, have a somewhat lower rate of increase.—G. E. Partridge.

Basic Experiments in Vocational Guidance. *C. S. Yoakum.* Jour. Personnel Research, May, 1922, 1, No. 1, 18-34.—This is a comprehensive study of the fundamental ideas of vocational guidance. It is shown that the general problems are to determine the nature and content of a position; to develop and improve present methods of job analysis; to define the degree of responsibility involved; to set forth opportunities for promotion with the search for collateral opportunities; and to state the knowledge required for the work. An important question is that of adjusting the wage according to the degree of responsibility of a position.

The study of human differences is another problem basic to vocational guidance. Variations in mental traits are wide, and one of the greatest differences is measured by the intelligence or mental alertness test. The army tests of 94,000 men indicate that there are several occupational levels corresponding to degrees of intelligence. This gives valuable information to be used in advising individuals. The intelligence test is shown to be an excellent measure of efficiency and success in clerical occupations, but excellence in mechanical work may not, as tests show, be at all correlated with intelligence ratings. A combination of two tests (not mental alertness tests) enables one to pick successful stenographers with almost 100 per cent. accuracy.

Mental tests applied to the whole personnel of one company showed a higher range of ability among executives than among clerks, indicating that even after years of experience the clerks could not compete with higher officials. Thurstone's tests have indicated significant differences in mental characteristics in groups of students electing different

studies leading toward different occupations. Other tests have been worked out by studying the differences of these students, and by analyzing and measuring ability in specific occupations, such as that of salesman.

An effort has been made to measure people's interests, their ability to meet other people, their temperamental differences, their aggressiveness, etc.

A third fundamental problem in vocational guidance is the determination of the genetically continuous and discontinuous traits of an individual.—G. E. Partridge.

Vocational Education in the Pulp and Paper Industry. *J. C. Wright.* Reprinted from Paper Trade Jour., 1921, pp. 5-71.—The writer has made a detailed study of the pulp and paper industry with reference to its educational problems. He finds an industry in which a large number of the workers are of relatively low skill, and a situation calling, in his opinion, for definite vocational training.

In organizing a complete training program in any industry consideration must be given to the duties and responsibilities of each different group of workmen. The aim is, therefore, to analyze the operations of the industry, and to correlate types of work with vocational training of the right kind. There is presented a useful analysis of the jobs in news print mills, groundwood mills, sulphite mills, and book and rag mills. The paper ends with a brief outline of a course of instruction in the pulp and paper industry, including general matters of elementary education and scientific knowledge involved.—G. E. Partridge.

SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

A Glass Blower's Pipe in Which Blowing with the Mouth Is Eliminated. *William Lippold.* Zentralbl. f. Gewerbehyg., March, 1922, 10, No. 3, 81-84.—A producer of glass for many years describes how he started to devise apparatus to replace glass blowing by mouth. The successful apparatus is now patented and in use. A diagram is given. The pipe contains a store of compressed air which is released by a valve controlled by either the operator's chin or finger, allowing the manipulations to be very similar to that of the old-fashioned pipe This pipe facilitates the blowing of window glass, plate glass, and all sorts of bottle ware. It eliminates the dangers to glass blowers of damaged teeth, diseased lungs, enlarged heart, and catarrhal troubles in the respiratory tract.—E. L. Sevringhaus.

CENTRAL NERVOUS SYSTEM

Saturnine Neuritis. *Ettore Tedeschi.* Abstracted as follows from Riforma med., 1922, No. 3, in Il Lavoro, Feb. 28, 1922, 13, No. 2, 55-56.—This report deals with four lead workers—three of them in the printing trades, the fourth a painter—all suffering from ischialgia, confined chiefly to one side. Lead is considered to be the cause in all four cases, and the author regards the condition as a neuritis affecting especially the second sacral nerve. Aside from the pain, the symptoms consisted in loss of tactile and heat sensation along the side of the leg and the outer margin of the foot of the affected side, showing involvement of the tibial nerve. Tedeschi believes that plumbic neuritis is more often localized in the lower limbs than is usually believed. The peroneal nerve may be involved and sometimes the internal popliteal. As a usual thing this neuritis is bilateral but, as in the cases reported, it may be confined to one side.—Alice Hamilton.

Occupational Dyskinesia — Paresthetic Type. *C. Houllion.* Abstracted as follows from Rev. neurol., April, 1921, 28, p. 348, in Arch. Neurol. and Psychiat., May, 1922, 7, No. 5, 656.—"The author comments on the perplexing problem presented by the occupational spasms, so-called, directing attention to the importance, in this field, of Duchenne's work, according to which such disorders are classified as motor and sensory, including under the former the akinetic, hyperkinetic (classical cramp) and ataxic (tremors, choreiform and ataxic movements) types. The

purely sensory type, of which Houllion's case is an example, is deemed extremely rare, but, on the other hand, sensory disorders of some kind, such as anesthesia, paresthesia and 'neuralgia', are frequently encountered as complicating features in the more essentially motor types.

"Houllion's case was that of a seamstress, 56 years of age, with a negative family and personal history, except that both the patient and her mother were described as of a 'nervous' temperament. The present trouble dated back three years and manifested itself primarily as a severe tingling and numbness in the fingers and hand (right), occurring characteristically in the morning, particularly after the patient had sewed for a long time or had done extensive laundering the preceding day. This trouble was usually first noted about fifteen minutes after she commenced to sew in the morning, and beginning in the finger tips, gradually extended so as to include the entire hand, with short periods of intermission, continuing until it was no longer possible to hold the needle. At such times the hand appeared ischemic with an accompanying sensation of frigidity but with no associated spasm or rigidity. On dropping the needle and holding the hand pendent or immersing it in hot or cold water, the paresthesia soon disappeared, only to recur, however, on the resumption of sewing. This situation would repeat itself from six to eight times, following which the patient was able to sew for the balance of the day without further discomfort. Curiously, no disturbance was found to occur if the patient preceded her morning sewing by a period of other work, and no difficulty was ever reported at night. The course of the disorder had apparently not been progressive and had been marked by phases of complete remission over periods — one of them several months in duration — when needlework had been discontinued.

"Neurologic examination was negative except for slightly increased sensitivity of the right arm trunks to electrical stimulation.

"Mention is made categorically of the various hypotheses which have been advanced as to etiology, the author seeming to favor that of perverted vasomotor habit or 'neurosis' dependent, presumably, on basic autonomic imbalance or dysfunction."—M. C. Shorley.

NEUROMUSCULAR SYSTEM

Two Cases of Paralysis of the Serratus Magnus. *Giovanni Allevi.* Il Lavoro, April 30, 1922, 13, No. 4, 105-109.—Paralysis of the serratus magnus, partial or complete, may be caused by trauma, or may follow certain infectious diseases, especially typhoid fever, or may be involved in an atrophic paralysis, such as poliomyelitis. Certain occupations also may be attended with paralysis of this muscle, such as the work of porters, blacksmiths, masons, rope makers, and soldiers, which involves pressure or stretching or wounding of the long thoracic nerve. Therefore prolonged pressure of heavy weights on the shoulders, the frequent lifting of heavy weights, blows on the shoulder, wounds, etc., may be followed by such a paralysis. The course of the disease is relatively slow.

It is a rare affection. Among about 15,000 cases of accident which have come to the medico-legal department of the Humanitarian Society of Milan, the following two are the only cases of paralysis of the serratus magnus. One was a vintner, 18 years old, whose work required him to carry heavy weights on his shoulders every day. The second, also a young man of 18 years, was a mason's apprentice who also had to carry heavy weights on his shoulders. Both had a bilateral paralysis which was shown, when the patient was at rest, by the action of the opposing muscles, the rhomboids, elevators of the scapula, etc., which, in paralysis of the serratus, separate the scapula from the thoracic wall and draw its inferior angle toward the vertebral column.

In normal subjects, raising of the arm above the head is effected by the deltoid, the serratus magnus, and the trapezius, but when the serratus is paralyzed the arm cannot be raised beyond a plane horizontal with the shoulder. If, in paralysis of the serratus magnus, the arm is lifted forward, the scapula, rotating on its internal angle, separates from the thoracic wall so that a depression appears between the two and the scapula assumes a wing-like appearance. Both patients showed these signs clearly.—Alice Hamilton.

RESPIRATORY SYSTEM

On So-Called Saturnine Asthma. *Tedeschi.* Abstracted as follows from Riforma med., 1921, No. 48, in Il Lavoro, Feb. 28, 1922, 13, No. 2, 53-55.—Two men presenting all the signs of chronic lead poisoning suffered from attacks of bronchial asthma, which in its course differed distinctly from uremic asthma and from that which accompanies uncompensated cardiorenal disease. The author attributes the asthma etiologically to the occupational poison which was undoubtedly present. The first case was in a type-founder who had suffered attacks of bronchial asthma for six years. In the intervals between attacks he had no positive signs in the chest except harsh respiratory sounds, but during and after an attack the usual findings in bronchial asthma, with Curschmann spirals and eosinophils in the sputum were present. These attacks were always more frequent when the man went back to work after a period of rest. When he changed his trade they diminished in frequency for about twenty months, and then disappeared. The history of the second case, a ship painter who had had attacks of typical asthma for eight years, was much the same, and he, too, was relieved by change of work. —Alice Hamilton.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Industrial Mercurial Poisoning. *Luigi Devoto.* Il Lavoro, Jan. 31, 1922, 13, No. 1, 18-20.—The majority of authors hold that industrial mercurialism appears as a chronic process, never as an acute process. A subacute form is sometimes reported, but no definite clinical picture of subacute mercurialism has been described. Teleky says that subacute industrial mercurialism represents a mild or abortive form in which stomatitis is never absent and it may be the only symptom. Others mean by this term a form of mercurialism with unusually rapid development, while Letulle uses subacute mercurialism only for that form of poisoning which is caused by the use of mercurial remedies.

Devoto describes three cases of industrial mercurialism which he saw recently in employees of a storage battery factory. These patients had the classical triad of mercurialism, stomatitis, tremor, and presence of mercury in the urine, but Devoto considers them instances of subacute poisoning because of the rapid development of the intoxication and the rapid elimination of the poison. The mercury was absorbed in vapor form, which may explain the peculiar course of the intoxication. The rapid development of stomatitis, tremor, and erethism made it impossible for the men to continue at work, and protected them from further exposures to the poison. The symptoms had disappeared after a few weeks and with equal rapidity mercury disappeared from the urine. The recovery of these men was greatly assisted by absolute rest in bed, a treatment which Devoto highly recommends.—Alice Hamilton.

The Effort to Rehabilitate White Lead. *L. Ferrannini.* Il Lavoro, Jan. 31, 1922, 13, No. 1, 24.—In a paper given before the Twenty-Seventh Congress of Internal Medicine at Naples, October 25, 1921, Ferrannini criticizes the efforts now being made in Germany and in England to minimize the dangers of white lead and to attribute the intoxication of painters to turpentine. He believes that this effort is not prompted by disinterested motives and that it has no scientific basis. Clinical and pharmacological evidence shows a great difference between the effects of lead and of turpentine, and the greater industrial morbidity of painters as compared with makers of white lead is due not to the harmfulness of turpentine but to the fact that hygienic measures can be applied in white lead factories which can be carried out only with great difficulty in painting.—Alice Hamilton.

The Opinion of the Governments of the Australian States on the Use of White Lead in Painting. Internat. Labour Rev., May, 1922, 5, No. 5, 819-829.—An inquiry on the use of white lead in painting was conducted by the Board of Trade of New South Wales and answers were submitted to the International Labour Office by the other Australian states.

It was found that while the average age at death of all occupied breadwinners was 57.8, that of painters was 53.5. During the period 1909-1915 the index of mortality for painters was found to be 12.9, while that for all occupations was 12.0. Excess of death among painters from certain diseases—Bright's disease, tuberculosis, lead poisoning—was reported, and insanity from lead poisoning was said to be more frequent among painters. "The Board is of the opinion that the evidence from administrative and trade experience is conflicting and unsatisfactory, but tends, nevertheless, to support the conclusions drawn from statistics."

Memoranda were submitted by the Commonwealth of Australia and by Western Australia, South Australia, Queensland and Tasmania. A total of 123 deaths from lead poisoning occurred in the commonwealth during the period from 1908 to 1918. The report from Western Australia emphasized several points, such as the importance of other substances than white lead in causing sickness among painters, the avenues through which poisoning takes place, and the sanitary means of prevention of poisoning. Communications from the other states were brief and unimportant.—G. E. Partridge.

THE ELECTRIC CLYSTER FOR THE TREATMENT OF LEAD COLIC. *Andrea Vinaj.* Il Lavoro, April 30, 1922, 13, No. 4, 109-113.—In the clinic for occupational diseases in Milan, Vinaj, an assistant of Preti, treated a series of cases of lead colic by the method recommended by various French authors (Labadie, Lagrave, Boudet, etc.) for intestinal obstruction, namely, by introducing into the lower bowel an injection of warm water through a sound which is at the same time the positive pole of an electric battery. The negative pole, covered with moist absorbent cotton, is placed on the abdomen. In order to guard against the possibility of forming an eschar in the intestine, about a liter and a half of water is introduced before the galvanic current is turned on. According to the toleration of the patient the current is increased, but never beyond 50 millimilliamperes, and the current is sometimes interrupted, again reversed.

Vinaj gives the history of eight cases in all of which pain was relieved during and after the treatment and constipation usually overcome with great promptness.—Alice Hamilton.

THE TECHNIC OF EXAMINING BLOOD FROM LEAD WORKERS. *H. Engel.* München. med. Wchnschr., April 28, 1922, 69, No. 17, 626-627.—Comparison of the usual fixed and stained thin smear of blood with the unfixed thick drop method which has been used widely in the last few years shows that the newer method finds basophilic degeneration in normal blood, at times, and more of the stippled cells in cases of lead poisoning than does the older and standard method. This stippling is not the same as the recognized marking of basophilic degeneration, and is probably an artefact due to the stain. The method is therefore not reliable unless used with great caution. Further research is being carried on.—E. L. Sevringhaus.

THE POISONOUS PROPERTIES OF COLLOIDAL SILICA. *W. E. Gye* and *W. J. Purdy.* Brit. Jour. Exper. Pathol., April, 1922, 3, No. 2, 75-94.—*Effects of the Parenteral Administration of Large Doses.*—Silica sol administered parenterally is a poisonous substance. Injected intravenously in very large doses it causes immediate death, as a result of clotting of the blood. Injected in sublethal doses it accelerates the rate of clotting of the blood when shed. Added to blood in vitro it has no influence on the rate of clotting. Silica sol injected intravenously in rabbits in daily doses of 30 to 72 mg. causes death in from two to four days, and postmortem petechial hemorrhages and profound degeneration of the liver and kidney are found. The conclusion is drawn that the primary action is on the vascular endothelium.

Effects of Repeated Intravenous Injections on Rabbits: Fibrosis of the Liver.—The intravenous injection of 5 mg. or more of silica sol daily in rabbits is followed by fibrosis of the liver, enlargement of the spleen, and changes in the kidney resembling interstitial nephritis.

The weekly injection of 5 mg. of silica sol has but little effect on the liver and kidney, but in both organs the changes found, though small, are quite definite. Only one animal

was used in this experiment, and the conclusions drawn are, therefore, provisional. It would appear from this single result that, in order to cause an abundant formation of connective tissue with this dose, the injection of silica must be repeated daily. If seven days are allowed to elapse between the administration of the doses the lesions produced by each dose heal quite completely before the next dose is given. When the weekly dose is 30 mg., a very definite fibrosis of the liver and degeneration of the kidney are produced in a few months. (The single result reported in this paper has been confirmed in other experiments which will be published later.) From this it may be concluded that the damage to cells caused by 30 mg. of silica sol is too extensive to be healed completely in one week, and that a chronic pathological condition is induced, fibrous tissue being formed in the constant attempt at repair.

Each article contains excellent illustrations showing the pathological changes produced in the liver and kidney. The authors do not refer to the significance of their work to the problems of pulmonary silicosis. Nevertheless, those interested in the pneumokonioses are bound to draw the conclusion that the well-known fibrosis of the lungs which follows prolonged inhalation of silica dust must be a reaction similar to that now obtained experimentally.—E. L. Collis.

DANGERS TO HEALTH IN VULCANIZING WORKS. *O. Calamita.* Abstracted as follows in Internat. Labour Rev., April, 1922, 5, No. 4, 654-655.—"A clinical study of workers employed in vulcanizing rubber goods has recently been published by Dr. Calamita, a member of the medical inspection staff of the Rome Labor Office. His investigations covered seven workshops and twenty workers, and the various methods of vulcanizing were all examined. An elaborate clinical examination of the employees was followed by detailed blood tests and inspection of the sanitary conditions of the workrooms.

"Dr. Calamita states that one-third of the workers suffered from chronic poisoning. He considers that this is caused by benzol mixed with other substances (helped by the bad ventilation), rather than by carbon disulphide of which very little is used, or benzine, which is freely used, but is not very poisonous. Persons predisposed to the poison are affected sooner than others. The most usual symptoms are debility, oligaemia, diminution of the haemoglobin, morphological changes in the red corpuscles, reduced resistance of the red corpuscles, eosinophilia (which may be severe), and irritation of the respiratory system.

"Among the precautions recommended are either better ventilation of workrooms by localized exhaust pipes, or prohibition of work in premises with insufficient floor and window space; strict exclusion of children under 15; improved vulcanizing solutions, a mixture of benzine and benzol being recommended in which the proportion of the latter has been reduced to the lowest limit technically possible; avoidance of the use of the highly poisonous carbon disulphide; frequent medical inspection of the workers, and examination for eosinophilia, when necessary; temporary exclusion from work of the workers most affected, and instruction of the workers in the poisonous properties of the substances used and the precautions which should be adopted."—G. E. Partridge.

THE HEALTH OF MUNITION WORKERS IN A SHELL-FILLING FACTORY. *J. Anderson* and *E. D. Anderson.* Abstracted as follows from Glasgow Med. Jour., 1922, 97, 1-16, by F. S. Hammett, in Chem. Abstr., May 20, 1922, 16, No. 10, 1619.—"Report of 18 cases of toxic jaundice apparently due to the occupational hazard in handling or exposure to trinitrotoluene or its compounds."

DUST HAZARDS AND THEIR EFFECTS

REMOVING THE DUST FROM THE CASTING CLEANING ROOM. *C. C. Hermann.* Indust. Management, March, 1922, 63, No. 3, 171-174. —The author presents engineering data on cleaning shops, exhaust systems for reducing emery dusts, and describes the use of sand blasts, etc., with cyclone or centrifugal collectors.—P. Drinker.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Dental Caries of Gingerbread Bakers and Candy Makers in Nuremberg. *Anne Singer.* Zentralbl. f. Gewerbehyg., March, 1922, 10, No. 3, 65-80.—The author discusses the damage to teeth in the industries using lead, mercury, phosphorus, arsenic, copper, acid gases, coal tar derivatives, trichlorethylene, carbon bisulphide, and in the glass blowing and mother of pearl industries. Actinomycosis is mentioned. The effects of grain flour and sugar dust are the subject of statistical study.

The gingerbread industry is very large in Nuremberg. Caries of the teeth is found to be extraordinarily prevalent among the bakers of gingerbread and among confectioners, etc., who have to work in the dust of flour and sugar. A coating of these materials on the teeth makes a good medium for acid-producing bacteria. The author urges personal prophylaxis by scrubbing the teeth at least twice a day, and by semi-annual tooth inspection. The problem of educating the workers is touched upon. About one-seventh of the working population of Nuremberg is engaged in these varied occupations with high tooth hazards.—E. L. Sevringhaus.

Results of an Inquiry by the Austrian Society for Cancer Research and Prevention. *S. Peller.* Wien. klin. Wchnschr., Feb. 9, 1922, 35, No. 6, 121–127; Feb. 16, 1922, No. 7, 153–158; Feb. 23, 1922, No. 8, 183–185.—Most responses to the cancer questionnaire denied any relation between occupation and cancer mortality. Others noted innkeepers, physicians, chimney-sweeps, peasants and merchants as most susceptible.—B. Cohen.

Phthisis in the Book-Printing Industry. *Paul Gerber.* Wien. klin. Wchnschr., Feb. 16, 1922, 35, No. 7, 158-159.—Consumption among book printers and allied workers runs on the average for five years in a chronic or sub-chronic form. Lead poisoning appears not to influence the disease in any way.—B. Cohen.

Oil of Chenopodium in Ankylostomiasis. *Filippini.* Abstracted as follows from the Policlinico, 1921, No. 38, in Il Lavoro, Feb. 28, 1922, 13, No. 2, 57.—Filippini objects to the use of oil of chenopodium, especially in treatment of hookworm disease on a large scale. It is easy to set up lesions in the kidneys, disturbances in the internal ear, and even blindness, and it is therefore contraindicated in patients suffering from eye or ear disease. It is also contraindicated in anemia, and since the latter is invariably present in ankylostomiasis, this fact alone is enough to cause its rejection. There is no reason to prefer it to thymol.—Alice Hamilton.

Studies on the Chemotherapy of Silver and Arsenic Compounds in Experimental Tuberculosis. *M. I. Smith.* Am. Rev. Tuberc., May, 1922, 6, No. 3, 183-191.—The author summarizes as follows:

"An investigation was conducted on the chemotherapy of some arsenic and silver compounds in tuberculosis. The results permit of drawing the following conclusions:

"1. Neoarsphenamine and silver arsphenamine have a very slight inhibiting action on the growth of the tubercle bacillus *in vitro.* Colloidal silver oxide has no effect whatever on its growth, while silver methylene blue has a very considerable inhibiting action on its growth.

"2. None of these substances has any demonstrable effect on the pathogenicity of the tubercle bacillus when exposed to their action *in vitro* at body temperature for forty-eight hours.

"3. None of these substances when administered to experimentally infected tuberculous guinea-pigs has any favorable influence on the course of the disease."—M. C. Shorley.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Hazards of Dry Cleaning Establishments. *T. P. Endicott.* Nat. Safety News, June, 1922, 5, No. 6, 33-34.—The term "dry cleaning establishments" applies to those establishments that totally immerse garments in a solvent other than water—a process mak-

ing fire or explosion probable at any time without warning.

The author enumerates the several hazards involved in these houses, and suggests diminishing the dangers by correcting the location, lighting, use of solvents, ventilation, drying, and electricity of the establishments.—M. C. Hamblet.

THE ECONOMIC RELATION OF ACCIDENTS AND PREVENTABLE DISEASES TO THE COAL-MINING INDUSTRY. *A. L. Murray.* U. S. Bur. Mines, Reports of Investigations, April, 1922, pp. 5. —The study is based upon the experience of coal mining camps in the state of Utah. It is shown that the number of accidents tends to increase year by year. When compared with production and the number of men employed, the fatality rate and the permanent disability rate for the four years (1917–1921) show a marked increase.

By analysis of data regarding days of loss, average wage, average tonnage per man per day, etc., the writer estimates a total loss from these accidents amounting to an average well above three-quarters of a million dollars per year or approximately 17 cents for every ton of coal mined.

A similar study is made of the losses resulting from two diseases—smallpox and typhoid fever. At first sight the loss from these diseases may seem to be inconsiderable, since they are infrequent; but when it is considered that they are preventable, and when the conditions that arise when an outbreak of these diseases occurs in a mining camp are taken into account, the loss cannot be regarded as insignificant. In the case of smallpox and typhoid fever, the means of prevention are so simple and so readily applied that the loss from these diseases may be considered inexcusable.

The monetary losses due to accidents and contagious diseases in the coal mining industry in Utah, as shown, average close to a million dollars per year.—G. E. Partridge.

REDUCING ACCIDENTS BY INCREASING NUMBER OF ACCIDENT REPORTS. *H. T. Aldrich.* Safety Engin., April, 1922, 43, No. 4, 140.—The unusual feature in this safety contest, which continues for one year, is that, instead of prizes being awarded to the department which has the lowest number of accidents for the year, they are given to the department that reports the largest number of accidents. This feature is preventing the development of complications arising from minor injuries. —R. M. Thomson.

OBTAINING AND PRESENTING SAFETY STATISTICS TO THE BUSY EXECUTIVE. *A. M. Underhill.* Safety Engin., April, 1922, 43, No. 4, 131; May, 1922, No. 5, 199.—This paper, which appears in two issues of *Safety Engineering*, correlates and presents facts and figures in safety work. After data have been collected and careful attention has been given to what they represent, the facts should be so presented that they are readily discerned by persons unfamiliar with the work.

Part II of this article shows by actual charts how to analyze accident statistics by graphic charts, and gives the most convenient forms of co-ordinate paper for use in plotting curves.—R. M. Thomson.

MORE ABOUT "SAVING FINGERS." *H. F. Webb.* Nat. Safety News, June, 1922, 5, No. 6, 26.—Through the efforts of the superintendent of the press department, The Watson Company, of Attleboro, Mass., has reduced accidents to a minimum. This has been done through safety education and co-operation of the employees. Several safety devices which have been installed in this plant are described.—M. C. Hamblet.

HOW ONE SMALL PLANT SOLVED THE SAFETY PROBLEM. *W. E. Magraw.* Nat. Safety News, June, 1922, 5, No. 6, 13.—The H. H. Robertson Company, Pittsburgh and Ambridge, Pa., is the winner of the Rice Safety Award for a 100 per cent. record in accident prevention during 1921. This company, employing 124 men, worked 250,000 hours last year without a lost-time accident. Although a workmen's committee and a general committee were formed, they were both discontinued and the idea of safety was directly inculcated in the minds of the workers by the foremen, who were responsible for the safety as well as for the production of their departments.—M. C. Hamblet.

HOW MOVING PICTURES HELP IN SAVING LIVES AND PREVENTING INDUSTRIAL INJURY.

Safety Engin., April, 1922, 43, No. 4, 138.—This is a general review of the part played by motion pictures in accident prevention, and contains an appreciation of the film as a means of increasing industrial safety.—R. M. Thomson.

INDUSTRIAL SURGERY

Types of Injuries Met by the Railroad Surgeon. *J. H. Blackburn.* Southern Med. Jour., Feb., 1922, 15, No. 2, 143–146.—Recent reports of the Interstate Commerce Commission show that 85 per cent. of the persons, other than passengers and employees, involved in railway accidents, are trespassers.

Several characteristics of railroad injuries deserve notice. The most striking in the writer's experience are the multiple nature of the injuries, the large number of lacerated wounds, and the comparatively marked degree of both primary and secondary shock.

Various types of injury are specified, and there are brief case histories of seven cases intended to illustrate the unusual or extraordinary features of cases in railway surgery.—G. E. Partridge.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

The Poison of Fatigue in Experimental Tuberculosis and in Consumptives. Abstracted as follows from Annali Med. Nav. e Colon., 1920, 2, 615 and 767, in Tubercle, May, 1922.—By way of preface to his own voluminous treatise, the author describes the researches of various biologists on the subject of kenotoxin—the toxin associated with fatigue. Particularly he is impressed with the work of Weichardt, whose theory was supported by Wolff-Eisner in 1905 and by Ferrannini and Fichera in 1912. He then proceeds to a description of his own experiments carried out in order to determine whether experimental tuberculosis is affected by the toxin of fatigue, and, if so, what is the mechanism of this influence. The kenotoxin was manufactured according to Weichardt's technic with only a slight modification. Rabbits were used for preparing the toxin, rabbits and guinea-pigs for the antikenotoxin. The author then proceeds to give full evidence for his conclusion that the kenotoxin so prepared will cause typical anaphylactic shock in the guinea-pig.

The influence of fatigue on tuberculosis morbidity was shown by infecting a group of guinea-pigs fatigued for a fortnight and a control group of equal weight which had been resting: the fatigued showed less resistance. With small doses of kenotoxin a similar result was obtained, but on increasing the dosage in a second series of experiments the intoxicated animals were found to succumb much more rapidly to infection with tuberculosis than did the controls.

The effect both of fatigue and of kenotoxin brought to bear after experimental infection with tuberculosis showed that both, and especially the latter, hastened the course of the disease and aggravated the symptoms.

The next step in the experiments was to determine whether antikenotoxin would neutralize the kenotoxin *in vivo*, the guinea-pigs being grouped according to whether they had had (*a*) kenotoxin only, (*b*) kenotoxin and antikenotoxin, or (*c*) neither kenotoxin nor antikenotoxin. Groups (*b*) and (*c*) survived with equal success, while in group (*a*) the disease was markedly aggravated. In other words, the ginea-pig treated with both kenotoxin and antikenotoxin behaved as a resting guinea-pig would, while the guinea-pig treated with kenotoxin only behaved like a fatigued guinea-pig.

A series of investigations into the effect of fatigue on immunity resulted in the following conclusions: (1) that fatigue diminishes the resistance of the animal to the action of the tuberculosis toxin (aqueous tuberculin of Maragliano); (2) that animals passively immunized and at the same time subjected to fatigue behave as those in the previous group when treated with tuberculin (fall of temperature, prostration, rapid loss of weight, and death), controls being able successfully to

withstand a lethal dose of tuberculin; (3) that bacteriolysis is delayed and diminished as a result of fatigue; (4) that fatigue results in a fall of the opsonic index and a diminution of the amount of antibodies present in the blood.

After these preliminary studies the writer broaches the more difficult question of the effect of fatigue in the human being. Without making any exploration into the tempting fields of etiology, Captain Pietroforte confines himself to the effects of fatigue on the course of a declared disease, keeping an eye on the application which must be made of his research to the exercise treatment of tuberculosis. The method selected for fatiguing the patients was to make them walk until they just began to feel tired. The healthy controls were subjected to a more marked degree of fatigue. Altogether fifteen patients were examined under these conditions, the results being classified according to the influence of fatigue on the temperature, pulse, respiration, blood pressure, metabolism, and weight. Obviously these results cannot be stated with the same clearness as is possible in a laboratory. The full observations of each of these fifteen cases are given in the paper. The main conclusions reached are that in tuberculous, as distinct from healthy individuals, fatigue is usually followed by azotemia, very slight azoturia, and diminution in weight. Temperature, pulse, and respiration show no notable changes, while the blood pressure is only seriously affected in the more advanced cases. Practically, he concludes that although fatigue is usually harmful to the tuberculous in whom the normal reactions of the healthy are absent, there may be found the chosen moment when it is actually useful. To this end careful account must be taken of the weight and of the nitrogen metabolism. The theory is that the toxin affects the metabolism through the central nervous system, and if given in sufficiently small and well-spaced doses its exciting action prevails rather than the paralyzing action which results from larger and continued doses.

Practical Methods for Reducing Fatigue. Nat. Safety Council, Safe Practices Pamphlet, No. 50, Nat. Safety News, June, 1922, 5, No. 6, 39–50.—After a definition of fatigue is given and the manifestations of fatigue are stated, about twenty-five personal or individual causes of fatigue are mentioned. Among the important factors causing fatigue are: poor health, personal worries, lack of adaptation to one's job, poverty, long hours of work, lack of amusement and recreation, and monotony in work. Enlargement of these factors, together with others causing fatigue, is made. This pamphlet may be obtained from the headquarters of the National Safety Council in Chicago.—M. C. Hamblet.

The Influence of Muscular Effort and Consequent Thyroid Stasis on the Formation of Goiter. *L. Mattioli.* Abstracted as follows from Rivista Sperimentale di Freniatria, Vol. 45, No. 1–2, in Il Lavoro, March 31, 1922, 13, No. 3, 88–90.—The author presents a series of anatomical and physiological studies which have a bearing on the causal relationship between muscular effort and goiter already observed by others. In the course of ten autopsies he examined the veins of the thyroid gland and came to the conclusion that the superior thyroid veins, because of their direction from below upward, are ill adapted, even during the state of repose, to favor the return flow of blood from an important part of the gland, as a result of which the upper part of the thyroid is more subject to venous stasis than the lower part, and the right lobe more than the left.

In mountaineers carrying their load on their shoulders as they climb, this stasis in the thyroid veins results in an increase in the circumference of the neck, as the author found in nine individuals. These men also showed a notable increase of pulsations, of respiratory effort, and in almost all there was increased blood pressure. To this effect on the venous system of the thyroid produced by the mountaineer's work is added another, a slowing of the flow in the internal jugular veins because the omohyoid muscles cannot, under these circumstances, contribute to the dilatation of the large veins of the neck, as they do normally.

These observations lead the author to believe that the peculiar work of the Italian mountaineer is calculated to provoke stasis in the thyroid gland and consequently to produce anatomical and functional changes

which influence the unknown agent that causes goiter; and that such work must therefore be regarded as a contributory cause of goiter. A confirmation of this theory is found in the progressive disappearance of goiter in parts of Italy where the carrying of heavy weights on the shoulder up the mountains is being abandoned, and transportation done by animals.—Alice Hamilton.

Energy Expenditure in Sewing. *C. F. Langworthy* and *H. G. Barott.* Am. Jour. Phys., Feb. 1, 1922, 59, No. 1, 376-380.—The authors summarize as follows: "The respiration calorimeter was used to measure the energy expended by a woman hemming by hand on various materials and at different speeds and doing similar sewing on a machine driven by foot power and by electricity. Little variation was found in the energy required for hand hemming on fine handkerchiefs, cotton sheets, 8-ounce cotton duck, and army blankets, the energy required for the actual sewing running between 5.5 and 5.8 calories per hour except in the case of army blankets where for some unexplained reason it was only 4.3 calories.

"When the speed was increased, the energy output increased proportionately. Hemming sheets on a foot-driven machine required about six times as much energy per hour as doing the same work by hand, but the energy used per meter of sewing was hardly one-half as great. When an electrically driven machine was used, the energy required per hour was not quite twice that used for hand sewing and about one-fourth that for the foot-driven machine; the energy per meter of sewing was about one-fifth of that measured on the foot-driven machine and less than one-tenth that of hand sewing. A three weeks' attack of influenza during the progress of the experiments made it possible to compare the energy output of the subject before and after the infection. For five weeks after apparently complete recovery her energy expenditure per kilogram of body weight averaged nearly 1 per cent. lower than before her illness."—M. C. Shorley.

Alcohol in Relation to Industrial Hygiene and Efficiency. *T. Oliver.* Lancet, April 15, 1922, 202, No. 5146, 772.—Home conditions and habits, together with the nature of one's employment, influence alcoholism. By injuring the nervous system alcohol diminishes the ability to work, but as muscle food it is helpful, although the help is dearly bought. Many occupations, apart from the manufacture and sale of alcohol, create a desire for intoxicants; they are those productive of fatigue due to great physical exertion, overlong hours, exposure to heat or to dust. The alcohol habit is associated with increase in accidents and in irregular time-keeping. Conditions of work, as exposure to weather in shipbuilding, conduce to the habit. Sailors at sea are well behaved and sober, but on arrival in port with accumulations of pay they tend to break loose; here occupational customs exert a bad influence.

Before America banished alcohol, it could be said that teetotal nations, such as the Mohammedans in Asia and eastern Europe, were behind others in vigor and industrial progress. Experience does not teach that the man who uses alcohol out of working hours with care and moderation is inferior as a craftsman to the abstainer.—E. L. Collis.

The Use of Alcohol by Industrial Workers. *E. L. Collis.* Lancet, April 15, 1922, 202, No. 5146, 773.—(*Review by author.*) Alcohol contains some energy but it is not true food. It is, rather, a sedative drug with toxic properties. The development of industry saw a rise in alcoholism, probably aided by the drive of mass production with the need to keep the pace which tires and irritates the worker. Alcohol is a convenient sedative for blunting these sensations. Improved conditions of work with regard to wages, hours, and the supply of food lessen intemperance. Drink taken during working hours, as by dock laborers, is more injurious than when taken only convivially, as by coal miners. Investigations have shown that the sedative action of alcohol impairs those forms of sensitivity especially required for industrial work, and results in less output and more accidents; while its intoxicating properties are accountable for increase in labor turnover and lost time.

HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

Industrial Code Rules (as Amended) Relating to Work in Compressed Air Tunnel Construction. New York State Dept. Labor, Bulls. No. 22 and 25.—Regulations relating to general tunnel construction, and to tunnels and caissons, are presented.—M. C. Hamblet.

WOMEN AND CHILDREN IN INDUSTRY

Maternity and Industrial Work. *Pericle Carlini.* Reviewed in Il Lavoro, March 31, 1922, 13, No. 3, 90–93.—Carlini has collected the literature on the influence of industrial poisons on the pregnant woman, on parturition, and on the offspring, adding some personal observations. The poisons which form the subject of this book are tobacco, lead, phosphorus, mercury, arsenic, alcohol, ether, carbon disulphide, zenzine, antimony, trinitrotoluol, picric acid, and bichromate of potash.—Alice Hamilton.

Women Who Work. New York State Dept. Labor, Special Bull. No. 110, April, 1922, pp. 40.—This report contains useful information about women in industry. Occupational figures are given for the United States and for New York with reference to women workers, also data relating to hours of work, wages, home work, and workmen's compensation. There are also data on health and trade union organization. The report closes with an abstract of the laws of New York State respecting the employment of women.

It is shown that of 4,504,791 persons gainfully occupied in the state of New York, 25 per cent. are women, and that 44 per cent. of all persons following professions in the state of New York are women. As a group, working women are younger than working men. The hours of their work are generally limited in mercantile establishments, factories and restaurants to nine hours a day, fifty-four hours in a week. Employment is prohibited between 10 o'clock at night and 6 o'clock in the morning. Two large groups—professional workers and those in domestic service—are not limited by law. Of 24,000 licensed home workers, about 18,000 are women. When we turn to the very important question of health, we are confronted with a most deplorable dearth of facts regarding the amount of time and wages lost on account of sickness. A recent study shows that the rate of illness is 50 per cent. higher for women than for men both in regard to the number of cases of sickness per thousand employed and in regard to the average loss of time per capita. Accidents in industry in 1920 are much more frequent among men (96 per cent. of the total number), but two classes of women in occupational life have no compensation for accidents—those in domestic service and those in agriculture.—G. E. Partridge.

Negro Women in Industry. U. S. Dept. Labor, Women's Bur., Bull. No. 20, 1922, pp. 65.—Negro women in industry in nine states — New York, Pennsylvania, Ohio, Illinois, Michigan, Indiana, Virginia, West Virginia, and North Carolina — were considered in preparing this report. One hundred and fifty plants were visited, employing 70,409 persons, of whom 40.5 per cent. were women, and 16.8 per cent. negro women. More than one-half of the negro women were employed in the tobacco industry.

The war brought into the industries many more negro women than had hitherto been employed, but it is clear that at the time the present study was made, the negro women did not have a permanent footing in industry, and that the numbers employed have been greatly reduced since the war.

Of all the women studied, about one-third were working ten hours or more a day. All of the employees in the peanut industry were working ten hours or more; of a total of 840 negro women in the textile industries, 680 were working ten hours or more, and nearly half of those working in the tobacco industry were in this same group. The greatest number, 37.4 per cent., were employed fifty hours per week. Gross faults in regard to over-

time working were found to be prevalent, and it was also found that a great many of the women had home duties in addition to their factory work. Many of the establishments allowed too short a period for lunch (eighty-eight had a half-hour period). The general working conditions were almost universally poor. Provisions for health service "varied from the best to the worst types." In eighteen establishments adequate and sanitary first-aid dispensaries were found under the supervision of trained nurses. In 128 places there were either no seats for these workers or only makeshifts.

Data are included showing the occupations of negro women in comparison with those of white women in a variety of industries; there are sections on wages, employment policies, education and training of workers, and efficiency. It is clearly shown that negro women in industry have proved themselves, as a class, dependable and capable.

The report ends with a study of home conditions of women workers in Virginia, consisting of an investigation by personal visits of the home conditions of eighty-five negro women employed in the tobacco industry.—G. E. Partridge.

Children of Wage-Earning Mothers. A Study of a Selected Group in Chicago. *Helen R. Wright*. U. S. Dept. Labor, Children's Bur., Pub. No. 102, 1922, pp. 92.—This pamphlet concerns the effect of the employment of mothers upon the welfare of their children. The nature of a mother's work, her hours, the conditions under which she works, and her earnings, play such a large part in determining the welfare of her children that these conditions have been studied.

Special protection needed by the children of wage-earning mothers consists of protection which should be afforded them during the mother's working hours and measures that should be adopted in order that the children may not be deprived of proper care and attention by the mother during the hours she is at home.

The facts brought out in this report point clearly to the conclusion that industrial employment of mothers has many undesirable features. Chief among these may be mentioned the mother's absence from home, and the fatigue and ill health which inevitably occur when a woman shoulders two jobs. The connection of these factors with the children is obvious and calls for measures which will remove the necessity for mothers to work outside their homes. These measures will operate for the benefit of both mothers and children.—M. C. Hamblet.

Industrial Home Work of Children. A Study Made in Providence, Pawtucket, and Central Falls, R. I. U. S. Dept. Labor, Children's Bur., Pub. No. 100, 1922, pp. 80.—The industrial home work of children in Rhode Island was brought to the attention of the Children's Bureau through the reports of inspectors charged with the enforcement of the federal child labor law of 1916. Detailed information, gathered largely through a canvass of the schools, was obtained for 2,338 of the 5,006 children under 16 years of age who had done home work during 1918. These children had been engaged on home work for thirty days or more during 1918 and had received compensation for their services. Almost one-third of the children had foreign-born fathers, representing twenty-four nationalities. The largest numbers of child workers lived in the Italian district; more than one-fifth of their families owned their homes.

The children worked on about 100 varieties of factory work, distributed by twenty-one industries. The principal occupations of the children, in the order of their importance, were carding snaps, stringing tags, drawing threads on lace, linking and wiring beads, setting stones, working on military buttons, carding shoe buttons, finishing underwear, carding jewelry, and putting together chain fasteners. Eyestrain from home work was reported by 117 children. School teachers reported that child home workers came to school listless and tired. A possible danger to the health of the community was found in the fact that large numbers of families reported that work was carried on at home while members of the family were ill with infectious diseases, while in many cases the sick persons took part in the work.—M. C. Hamblet.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Atmospheric Pollution from Sulphuric Acid Plant Fumes. *James R. Withrow.* Chem. and Metall. Engin., May 24, 1922, 26, No. 21, 972-976.—This article, which reports the work of the Atmospheric Pollution Committee of the American Institute of Chemical Engineers, contains a discussion of the importance of the fume problem to the chemical manufacturer from the standpoint of public health, legislation, and economical operation. The author compares the situation in this country with that prevailing in Great Britain and Germany, and intimates that the sulphuric acid fume nuisance can be lessened by more efficient plant operation. He discusses present methods of determining the percentage of fumes escaping into the air, and the effect of humidity, light, temperature, and duration of exposure in connection with vegetation exposed to sulphuric acid fumes. —P. Drinker.

The Industrial Smoke Problem. Abstracted as follows from Wärme u. Kälte-Tech., 1922, 24, 20-34, by J. L. Wiley, in Chem. Abstr., May 20, 1922, 16, No. 10, 1657.—"The injurious constituents of industrial smokes and fumes and their effect on vegetation are discussed."

The Elimination of Industrial Organic Odors. *Y. Henderson* and *H. W. Haggard.* Jour. Indust. and Engin. Chem., June, 1922, 14, No. 6, 548-551.—This article contains a description of the authors' patented process (U. S. Patent 1,410,249) involving the admixture of small amounts of chlorine, as a deodorant, with the gaseous emanation from offensive organic matter. Chlorine is supplied from tanks, and involves only equipment in current use in the chlorination of water. It is pointed out that the gaseous volume of material actually odoriferous is extremely small, so that far less chlorine is needed than if the decaying organic material itself were to be deodorized by the same method. Certain details of the process as installed in a garbage-treating plant in New Bedford are given.—P. Drinker.

Spring House Cleaning in the Industrial Plant. *G. A. Kuechenmeister.* Nat. Safety News, March, 1922, 5, No. 3, 11-12. —This article concerns plant cleaning. Assuming that the method of cleaning, whereby an entire establishment is turned into confusion for several days annually, is obsolete, the author states that by keeping windows clean, by improved lighting, by the methodical arrangement of articles, and continuous sweeping, the spring house cleaning of the industrial plant will no longer be necessary. —M. C. Hamblet.

Industrial Code Rules (as Amended) Relating to Lighting of Factories and Mercantile Establishments. New York State Dept. Labor, Bull. No. 18, May 1, 1922. —The State Industrial Commission of New York has amended its labor laws relating to lighting of factories and mercantile establishments by establishing definite requirements for the measurement and intensity of illumination. The minimum intensities of thirty-two industries are given. — M. C. Hamblet.

A Survey of Natural Illumination in an Industrial Plant. *C.-E. A. Winslow* and *L. Greenburg.* U. S. Pub. Health Ser., Pub. Health Rep., April 14, 1922, 37, No. 15, 876-887.—This is a study of daylight illumination in a large munition factory, referring especially to the indoor-outdoor ratio as an index of such illumination. Measurements in forty typical workrooms were taken with the Macbeth Illuminometer. The general results were good, with only 10 per cent. of all observations (402) falling below 2 foot-candles, and 65 per cent. were over 10 foot-candles. The indoor-outdoor ratio has certain limitations, but a common sense interpretation of the results will yield findings that are probably more significant than direct readings of indoor daylight illumination.

"It may be tentatively concluded that in summer an indoor-outdoor ratio of 0.4 per cent. will almost always give a direct illumination of over 2 foot-candles, generally a value

of over 4 foot-candles. On the other hand, a workroom with an indoor-outdoor ratio often falling below 0.4 per cent. is likely to show a considerable proportion of observations below 2 foot-candles.

"Two foot-candles of direct illumination, or 0.4 per cent. of the outdoor illumination at a given time may perhaps be taken as a tentative standard for general daylight illumination in such an industry as small-arms manufacture, with special illumination at particular working planes where inspection and other fine work are carried on."—B. Cohen.

Notes on the Efficiency of Various Systems of Air-Conditioning in a Munition Factory. *C.-E. A. Winslow* and *L. Greenburg.* U. S. Pub. Health Ser., Pub. Health Rep., Feb. 10, 1922, 37, No. 6, 275.—Notes on artificial and natural ventilation in use in a shell manufacturing plant accompany charts and tables of extensive readings from psychrometers, kata-thermometers, and carbon dioxide in parts per 10,000 of air. The authors conclude that shops with only the normal heat hazard can be greatly improved by common sense and the judicious use of thermometers, while heat hazards of a high degree of intensity can be adequately controlled during cool weather by properly designed and operated systems of fan ventilation. In summer the excessive heat can be reduced only by artificial cooling and in the absence of this desideratum short working shifts are recommended.—P. Drinker.

Have You a Good Drink of Water in your Plant? *G. E. Wallis.* Nat. Safety News, May, 1922, 5, No. 5, 27-29.—In this article there are presented several methods of supplying cool drinking water to employees in industrial establishments.

The two most important factors to be considered in planning the drinking water system are: first, the source from which the water is taken (many plants use the municipal water supply although it is cheaper to use an artesian well and pump the water through the plant); and, second, the water distribution within the plant itself (most industries use a system including filtration, refrigeration, and continuous circulation). After the passage of the water through a pressure filter, it may be conducted to a cooling and supply tank from which it is pumped to the fountains in the plant.

Investigations indicate that the bubbler fountain throwing a vertical stream of water is still a source of disease, germs often being bounced up and down at the top of the vertical stream for eighteen hours. The type of fountain that throws a stream at an angle so that dust or germs cannot fall into the mouth of the fountain is more sanitary.—M. C. Hamblet.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

First Aid Service in Federal Building. Hosp. Management, March, 1922, 13, No. 3, 58.—The government has recently established dispensaries in several federal buildings in the East and in Chicago, and has now under consideration the extension of this project. The building at Dearborn and Adams Streets, Chicago, a center for about 7,000 employees, was the first post-office building to establish first-aid service, and in the short time it has been operating the service has given such good results that larger quarters are being prepared. During February, 1922, there were 3,882 calls for dispensary service, largely minor cases. First aid, alone, is provided by the dispensary at the present time, but the service is under the direction of United States Public Health Service Hospital No. 30, which cares for all cases requiring hospital treatment. A twenty-four-hour service is provided, with three shifts of physicians and nurses.—G. E. Partridge.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

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CONTENTS

GENERAL

INFLUENCE OF INDUSTRIAL EMPLOYMENT UPON GENERAL HEALTH. *Major Greenwood.* (Milroy Lectures.) Brit. Med. Jour., April 29, 1922, 1, No. 3200, 667-672; May 6, 1922, No. 3201, 708-713; and May 13, 1922, No. 3202, 752-758.—The wide erudition of the lecturer is displayed in his references to ancient industry drawn, for the most part, from writers during the Roman Empire; but not from them, not even from Galen, is information forthcoming as to the influence of industry upon the health of the laboring classes. With the single exception of the writings of Ramazzini the search for information proves fruitless, until the industrial revolution of the eighteenth century had profoundly altered methods of production and the life of the workers.

Dr. Greenwood is essentially an epidemiologist, an expert in the use of his own methods of inquiry. First he compiles a picture of the health of the working classes at the close of the eighteenth century and at the beginning of the nineteenth, and then proceeds to the Victorian era, thus arriving at the period of reliable vital statistics. Here the time of British industrial supremacy is found associated with an improvement in adolescent mortality, but with a deterioration in adult mortality, most pronounced in industrial districts. Simultaneously legislation was protecting the health of adolescents and of women by reducing their hours of work and improving conditions of labor. Adult mortality is found lagging behind and only improves as the survivors of the lessened adolescent mortality advance through adult life.

At this time English mortality is found to be higher than that of non-industrial Sweden up to about 40 years of age; after this age it is lower. Late in the century Sweden developed industrially but made little effort to protect juvenile labor; then the position was reversed. Although in both countries some fall in mortality at each age-period has occurred, today Swedish mortality exceeds that of England up to 35 years of age, but thereafter it is lower. The extremely unfavorable position in Sweden between ages 15 and 25 is attributable to industrial employment. Modern industrial life connotes urbanization; and the influence of town environment, as contrasted with rural conditions, has to be considered before any alteration noted may be ascribed to factory life. Hence the influence of migration from country to town is reviewed and the suggestion is made that adolescent migration may perhaps increase mortality in *both* populations—rural mortality by withdrawal of those best fitted to rural conditions; urban mortality by introduction of those ill adapted to urban conditions.

Tuberculosis is taken as an index disease—a more delicate index of hygienic conditions than general mortality; and records presented show that now in Sweden, which today is industrially at the position where England stood fifty years ago, mortality from the disease is at its maximum for both sexes at ages 20 to 30 (instead of in late adult life as it was one hundred years ago); whereas in England and Wales it is at its maximum for females at ages 35 to 45, and for males at ages 45 to 55. Similarly in Japan where this disease has tended to increase in recent years, the excess over English rates is most marked at ages 20 to 30. Four English towns—Reading, Northampton, Bolton, and Warrington—representing different industries, are closely contrasted from the points of view of climate, housing, and wages; the evidence appears to support an inference that industry in each case accentuates any climatological tendency to disease already existing, but no one industrial factor inimical to life is revealed by the investigation.

The lecturer then proceeds to examine the mortality of particular industries, using for the purpose English occupational data for 1910-1912. Here, taking the mortality of the clergy as a standard, he finds evidence from the boot trade that change of industry from home to factory has not been *relatively* favorable at earlier years, and has resulted in an undue prevalence of phthisis. Nevertheless it does not follow that an industry of which phthisis takes a heavy toll is an unhealthy industry, since mortality from other causes may be lower than usual; nor does it appear that the problem of phthisis-ridden industries is exclusively a problem of the recruitment of weaklings.

The reader is carried forward to the conclusions that the accepted ill effects of industry are not to be found in specific unhygienic conditions, but rather in the changes in methods of life imposed by modern industry upon populations not yet accustomed to them. These changes may be associated with (1) alterations in diet; (2) reduction of bodily exercise; and (3) the immediate effects of atmospheric change. Each of these influences is then discussed: nutrition as a factor determining the result of infection is held to be most responsible; bodily exercise calls for further investigation; but by studying and remedying defects in ventilation the resistance of the worker to the procataretic factors of disease may be strengthened.

These lectures contain such a mass of facts and careful deductions that an adequate summary is impossible. Only reference to the original can give the reader a full appreciation of the writer's work.—E. L. Collis.

Industrial Diseases. *T. M. Legge.* Ann. Rep. Chief Inspect. Factories and Workshops for 1921. Cmd. 1705, 1922, pp. 66-82.—An increase in the number of medical inspectors is reported which is permitting more special investigations to be undertaken, including an inquiry in industries in which there is danger of silicosis owing to exposure to dust. Probably owing to trade depression the number of notified cases of poisoning is lower than for the previous year. Deaths from lead poisoning have by no means grown fewer; there were twenty-three in 1921 with 230 notified cases, as compared with an average for 1902-1905 of twenty-three deaths with 601 notified cases. The secret is that deaths concern old chronic poisoning established before modern preventive measures were adopted, while the reduction in notified cases represents the immediate results of these measures. These results are also to be found in lessened severity in the cases; thus lead palsy was present in only 7.4 per cent. in comparison with 12.7 per cent. for the five years, 1910-1914.

Special reference is made to risk from using the oxyacetylene flame on painted steel

plates in breaking up old battleships; at the high temperatures generated 49 mg. of lead are given off as fumes in ten cubic meters of air, as compared with 3.4 mg. in the process of burning off lead paint with an oxygen and gas flame. At the same process Dr. J. C. Bridge found men cutting galvanized plates, suffering from typical brass founders' ague, due to inhaling zinc fumes of which there was risk of inhaling from 12 to 25 mg. daily.

For a diminution in cases of anthrax, from seventy-two in 1918, fifty-seven in 1919, forty-eight in 1920, to twenty-five in 1921, some credit is given to the inauguration of the station for disinfecting wool in bulk, at Liverpool; here material suspected of carrying infection, such as Egyptian wool and East Indian goat hair, has to be disinfected on imports before sale.

In the discussion of accidents from gassing, stress is laid on the importance of rest during the rendering of first aid, and rescuers are warned against walking victims up and down in their desire to be "doing something." Artificial respiration, warmth and rest are the essentials of treatment; premature exercise may be fatal. A special inquiry among workers employed in aniline black dyeing disclosed a diminution in hemoglobin, a fall in the number of red corpuscles and of white corpuscles with a relative increase in lymphocytes. Anemia and pallor were present, and also cyanosis, lassitude, and tremor; headache, drowsiness, dizziness, and loss of appetite were complained of. The symptoms were most prevalent at the process of dry ageing, and increased with the number of hours worked per week. Similar symptoms were also found among men employed at sieving paranitraniline.

The work of certifying factory surgeons is carefully reviewed and its value appraised. Extension of their work is recommended from merely dealing with certificates of fitness of young persons to giving medical advice and supervision of first-aid work. The chief medical reason for refusal to certify was the presence of pediculosis even though one officer found it impracticable to reject for this alone, since nits were present in the hair of about 30 per cent. of female workers, juvenile or adult. Close co-operation is needed between the surgeons and juvenile employment authorities, on the one side, and factory nurses and welfare supervisors, on the other.—E. L. Collis.

Dangerous Trades. *G. Stevenson Taylor.* Ann. Rep. Chief Inspect. Factories and Workshops for 1921. Cmd. 1705, 1922, pp. 33-49.—This article deals with progress in those industries which on account of some special risk to life or limb are certified as dangerous. The writer points out that active co-operation between occupiers and workers is necessary to reduce the toll of industrial diseases and accidents.

The chief risk of plumbism in making electric accumulators is found to be in lead burning processes, which can be made safer by efficient exhaust ventilation; vacuum cleaning appliances are advantageous for removing lead oxide dust which accumulates inside the shops. In dockyard work the main risk is from accidents; safety devices on winches, lifting gear and ladders, together with improved illumination, are effecting improvements.

In cotton and woolen mills personal carelessness is reported as causing accidents from self-acting mules, and steps have been taken to warn and prosecute workers. In contrast anthrax in the woolen trade is due to infected material, and only disinfection can remove the risk; this is now being undertaken centrally at Liverpool as the wool reaches port. The same applies to the manipulation of horsehair; and pressure is exerted to insure disinfection of hair coming from China, Siberia, and Russia, but difficulty is frequently experienced in tracing the country of origin of some special batch of hair.

Dust removal and suppression in the grinding trade and in the refractories industry are better carried out than heretofore; yet much remains to be done before the risk of silicosis is abolished. In various lead industries improvements are reported; by replacing common tinning in tinning of hollow-ware with pure tinning, exposure to lead fumes is diminished; on the other hand, in making pottery, low solubility lead glazes are replacing leadless glazes, but as they are also supplanting ordinary lead glazes, the balance is on the side of lessened risk; improved furnaces for lead smelting are improving working conditions; a new code of regulations for the manufacture of compounds of lead, that is, white lead, is

working satisfactorily. Taken as a whole the author tells a story of considerable advance in factory hygiene.—E. L. Collis.

Occupational Hazards and Diagnostic Signs. *Louis I. Dublin* and *Philip Leiboff*. U. S. Dept. Labor. Bur. Labor Statis., Bull. No. 306, April, 1922, pp. 31.—The Monthly Labor Bulletin of the United States Bureau of Labor Statistics, March, 1922, contained the first edition of this guide to the hazards of occupations and to the symptoms of the diseases which they cause.

A revised edition has recently been prepared, including abnormalities of temperature, compressed air, dampness, dust, extreme light, infections, poor illumination, repeated motion, pressure, shock, etc., and the poisons.

In preparing this revision the whole literature of industrial hygiene has been carefully examined, and the larger number of the more important occupations and hazards are now included.—M. C. Hamblet.

Factory Inspection in Sweden in 1920. Reviewed from Kungl. Socialstyrelsen: Yrkesinspektionens verksamhet, ar 1920, pp. 151: Stockholm, K. L. Beckmans Boktryckeri, 1921, in Internat. Labour Rev., June, 1922, 5, No. 6, 1004-1007.—The industrial inspection service of Sweden is responsible for the supervision of all employment except home work and nautical work. The central staff is aided by communal inspection authorities who oversee commercial and small industrial establishments. In 1920 there were also ten special inspectors. The total number of workplaces on the registers in this year was 44,310. In all, notices of defects were sent to 2,734 occupiers, and proceedings were taken in regard to 374 separate contraventions. Many of these notices related to the employment of young persons, especially to the failure to notify of their employment or to see that they had the required certificates. Some difficulty was experienced by the inspectors in explaining the new legal provisions respecting hours of work, and various problems of adjustment in this respect were met.

The accident returns are far above the prewar figures because of the change in the basis on which the statistics are compiled. For the year there were reported 37,195 accidents, including 348 fatalities, in industry; and 2,110, with twelve fatalities, in mining. In general the causes of accidents are not tabulated, but it is stated that agricultural machines caused 205 accidents of which eight were fatal, and that 982 persons were injured, eight fatally, loading or unloading vessels. There were 2,171 accidents on railways, of which thirty-three were fatal. Half of the fatalities occurred in shunting and coupling. In connection with electrical installations there were sixty-four accidents, of which twenty-three were fatal. Most of the more notable accidents were due to the explosion of steam boilers.

In connection with safety and hygiene, the report contains many illustrated notes. Especially useful devices are described; and also model installations, such as ventilation and dust-extracting systems, workers' lavatories and a guard for calender rolls. Dock work is given a special place in the report and it is said that there has been a distinct improvement in the supervision and testing of lifting apparatus.

There are returns on the medical examination of young persons. In 1920 there were 44,965 persons under 18 years of age recorded as being employed. Of these 2.4 per cent. were found to have deformities or outward defects; 1.6 per cent. had heart troubles; and 1.2 per cent. defects of vision. In many cases change of work was recommended and all employment was prohibited for 15 per cent. of the tuberculous cases. Criticism is made of the living conditions of the forest workers. —G. E. Partridge.

SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Preventive Measures Effective in Cardiac Diseases. *Louis I. Harris*. Nation's Health, Feb. 15, 1922, 4, No. 2, 74-77.—In campaigns against preventable diseases, one should not place too much confidence in the idea that education by itself will remedy conditions. Economic pressure, as well as ignorance and indifference, tends to render advice

alone ineffectual. Those who cannot afford to be examined by their own private physicians should be examined at the nearest Health Department clinic. The public must be persuaded to support more clinics and larger personnel, and to make possible the expansion of preventable disease work so that it will not be limited as at present to the prevention of tuberculosis alone.

Some method of vocational guidance and placement should be organized for persons of adolescent years who are about to enter industry, in order that those suffering from cardiac defects may be safeguarded. Those whose work involves marked fatigue should work fewer hours and should rest during certain prescribed periods. Cardiac patients under mental strain should be closely watched. Cardiac housewives should receive the assistance of paid day-helpers.—L. A. Shaw.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Observations and Experiences with Cases of Carbon Monoxide Poisoning in the Mine-Damp Explosion in the Frieden Mine at Oelsnitz. *W. Gorn.* Zentralbl. f. Gewerbehyg., April, 1922, 10, No. 4, 97-107.—Detailed case reports are given for the seventeen men injured in this explosion. The cases are divided into three groups: the first showed carbon monoxide in the blood, and had objective but not obvious neurological symptoms; the second group had severe burns in addition; and the third had severe enough effects of the carbon monoxide and the burns to cause great damage to the central nervous system and the circulation. In three cases large amounts of inspired or swallowed coal dust may have been an additional factor. The burns seemed to be the major cause of death.

The symptoms displayed were excitement followed by apathy, thirst, and retrograde amnesia. There were no paralyses or convulsions observed. The disturbance of the pupillary reaction seemed a criterion of the severity of the effect of carbon monoxide on the nervous system. Gorn argues at length that the damage caused by carbon monoxide is a direct intoxication of the nerve cells, and is not merely due to replacement of oxygen.

Treatment consisted in intravenous injection of adrenalin and strophanthin to stimulate circulation. Camphor was found ineffective. Oxygen was given by the Draeger apparatus, but was evidently not considered useful. Other possible lines of therapy are discussed.—E. L. Sevringhaus.

Unilateral Flaccid Paralysis Following Carbon Monoxide Poisoning. *Jaksch v. Wartenhorst.* Wien. klin. Wchnschr., 1922, 35, 262.—At least three such cases have come under the observation of the author. There is evidence of severe brain lesions. All showed (1) rise in temperature, (2) leukocytosis, and (3) transitory glycosuria.—B. Cohen.

The Tannic Acid Method for the Quantitative Determination of Carbon Monoxide in the Blood. *R. R. Sayers* and *W. P. Yant.* U. S. Bur. Mines, Rep. Investigations, Ser. No. 2356, May, 1922, pp. 7.—The authors summarize as follows:

"We believe the method described is particularly adapted to the requirements for determination of poisoning by CO gas. It can be used for either a quantitative estimation or in the absence of a set of standards it can be used as a qualitative test, the comparison in the latter being made with a single standard immediately prepared from 0.1 c.c. of the blood of an unexposed subject (very conveniently the person making the test). As support of the foregoing, the following conclusions are offered:

"1. The small quantity of blood needed can easily be obtained without objection on the part of the patient.

"2. The solutions used are cheap, common, and easily made. The apparatus used is simple and inexpensive.

"3. The actual time of making an analysis is not more than 3 minutes, and results can be obtained in 8 to 10 minutes.

"4. The accuracy is well within the required limits.

"5. No great skill or special training is necessary for securing good results.

"6. The method automatically corrects for any dissociation of carbon monoxide-hemoglobin due to the dilution with water.

"7. The results are more easily obtained, and are as a whole more dependable than with any other method tried."—M. C. Shorley.

Physiological Effects of Exposure to Low Concentrations of Carbon Monoxide. *R. R. Sayers, F. V. Meriwether*, and *W. P. Yant*. U. S. Pub. Health Ser., Pub. Health Rep., May 12, 1922, 37, No. 19, 1127-1142.—The conclusions drawn from this investigation are:

"1. The combination of CO with hemoglobin takes place slowly when the subject is exposed to low concentrations and remains at rest, many hours being required before equilibrium is reached.

"2. The combination of CO with hemoglobin takes place much more rapidly during the first hour of exposure than during any succeeding hour, with the subject remaining at rest.

"3. Strenuous exercise causes much more rapid combination of CO with hemoglobin than when the subject remains at rest. The symptoms of CO poisoning are emphasized by exercise.

"4. High temperature and humidity, with a given concentration of CO, cause more rapid combination of CO with hemoglobin than do normal conditions of temperature and humidity.

"All symptoms and effects described in this paper are called acute in character. None of the subjects has shown any permanent deleterious effects from exposure to CO."—B. Cohen.

Pathological Lesions Produced in the Kidney by Small Doses of Mercuric Chloride. *M. L. Menten*. Jour. Med. Research, June-July, 1922, 43, No. 3, 315-319.—The author summarizes as follows:

"Intravenous injections of mercuric chloride in amounts as low as 0.00002 gr. per kg. of weight cause microscopical pathological changes in kidney and liver of the rabbit. These lesions are well defined five minutes subsequent to the termination of the injection."

Inhalation of Petrol. *A. W. St. Ledger*. Abstracted as follows from Med. Jour. Australia, March 18, 1922, 1, No. 11, in Jour. Am. Med. Assn., May 27, 1922, 78, No. 21, 1668.—"While attempting to clear the petrol (gasoline) pipe of his car, Ledger's patient had sucked a considerable amount into his mouth. As this happened he caught his breath and some of it went down the wrong way. Immediately he had an acute pain in the right hypochondrium, stabbing and colicky in character, and much increased by respiration. The respiration was short and jerky and his breath smelt distinctly of petrol. There was no cyanosis or coughing. The respiratory movement seemed inhibited on the right side. The epigastrium was rigid and immobile. The rigidity was pronounced and accompanied by distention and tympany. There had been no vomiting. Six hours after admission he commenced coughing; the sputum was tinged with blood. The hemoptysis increased and with the increase of the pulmonary signs the abdominal signs became less definite and the picture changed to an acute pleuritic condition. Subsequently a marked effusion occurred and persisted for fourteen days. The fluid was gradually absorbed; tapping was not necessary. This case is of interest from the comparative rarity of its cause and the acute and confusing signs that resulted. Ledger regards the hemoptysis as due to a mechanical distention of the bronchioles, brought about by sudden volatilization of aspirated petrol. The abdominal signs were evidently referred through the intercostal nerves; the pleuritic effusion was secondary to the trauma."—C. K. Drinker.

Lead Poisoning. *F. Heim, E. Agasse-Lafont*, and *A. Feil*. Abstracted as follows from Bull. méd., Paris, March 18, 1922, 36, No. 12, 223, in Jour. Am. Med. Assn., May 6, 1922, 78, No. 18, 1424.—"Heim and his co-workers describe the two findings which warn of injury from lead even before the plumbism is well established. The number of leukocytes is usually normal, but about 40 per cent. may be mononuclears. The erythrocyte figure is also normal in the presaturnism phase. When the workmen are once saturated with lead, there is pronounced anemia, which is very slow in receding, even when there is no further contact with lead. The erythrocytes may show a basophil plasma or basophilic granules, and the latter is the earliest and

most constant sign of injury from lead. They have found it in 50 per cent. of all persons exposed to lead poisoning, regardless of whether they showed any signs of plumbism or not. This basophilic granulation is not found outside of lead poisoning except, inconstantly, in very severe anemia or certain grave intoxications. The granules show as fine black spots, some as fine as dust, others a little larger, scattered irregularly through the protoplasm. The other pathognomonic finding is the presence of lead in the urine, but the technic required to detect it is tedious, even with electrolysis and the colorimeter. They never found any lead in 100 normal urines tested, while it is constantly present in lead poisoning, as a large proportion of the lead is eliminated through the kidneys. The spinal puncture fluid may also show the presence of lead; in one of their cases this first explained a puzzling brain affection."—C. K. Drinker.

Measures for the Protection of the Health of Workers in Lead-Color Factories, and of Painters in Germany in 1920-1921. *K. B. Lehmann.* Zentralbl. f. Gewerbehyg., Feb., 1922, 10, No. 2, 46-51.—Following an investigation made at the invitation of owners of white lead factories, the author reports these observations. In regard to the hygiene and technical protection of workers there was evidence of great care. He considers that the chief risk now occurs at times when, through the failure of a machine to function properly, lead dust escapes into the air, and that the danger is rather to those persons who make small repairs about the plants.

The general appearance of the workers was good. Lehmann considers this condition due to the wartime interruption of their occupation, but he notes especially the apparent resistance of the "old-timers." He summarizes his examination (which will be published in detail later) with a table showing that approximately 70 to 75 per cent. of the workers displayed no distinct signs of lead effect. In considering his table he emphasizes the fact that 27 per cent. of the workers were 50 years of age. He closes with a table showing the reduction of cases of sickness and of sick days from 15 per cent. and 3.3 sick days in 1912 to 1914, to 3.6 per cent. and 0.75 sick days in 1919 to 1920. These figures are based upon the records of full-time workers. He regards this reduction as due to: (1) strict government legislation discussed in 1912 and carried into effect in 1920 (the making of pulp lead instead of lead ground in oil, dust protection, mechanical packers, and leaflets for workers, etc.); (2) improved status of workers and lessened turnover; and (3) greater care in the diagnosis of lead poisoning through the education of factory physicians.

In general the author thinks that dangers to white lead workers have decreased and can be still further reduced by the conscientious application of the most recent information regarding lead poisoning. Hazards in the painter's trade are considerably less than represented in many statistics.—J. W. S. Brady.

Tetralin Poisoning in Painters. *Alfred Arnstein.* Wien. klin. Wchnschr., 1922, 35, No. 21, 488.—Two painters were at work in a bank vault for three days. Tetralin (tetrahydronaphthalene) caused early irritation of the mucosa, also headache and stupor. The most striking symptom was a dark green coloration of the urine. The symptoms disappeared when the men stayed away from the work.

Tetralin is used a great deal in industry as a substitute for turpentine. Among other things, it is used in the preparation of floor wax, and it thus offers opportunity for the poisoning of many people.—B. Cohen.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Occupational Injuries to the Mouths and Teeth of Glass Blowers. *Hans Reichert.* Zentralbl. f. Gewerbehyg., Jan., 1922, 10, No. 1, 1-7.—The author emphasizes the fact that accounts of the investigations of specific dangers to the mouths and teeth of glass blowers have been neglected in literature. The author's investigation of the glass blowing industry is confined to the injuries of the mouths and teeth of workers, and discloses the following observations:

1. There occurs frequent transmission of

lues and tuberculosis, not to mention usual mouth-throat infection, from the use of a common mouthpiece on the blowing pipe.

2. The formation of large furrows or pockets in the mucosa of the cheeks is due to overdistention by blowing. This is found in about 90 per cent. of all workers examined.

3. Pneumatocele of Stenson's duct and the parotid is found in 12 per cent. of all examined.

4. The teeth are damaged. The author describes and illustrates with a photograph a characteristic abrasion of the incisors — especially the two upper centrals — produced by rotation of the pipe while blowing. He discusses the resultant injury to the appearance, speech, and the digestive tract.

Further injury is the loss of teeth caused by the "kick" backward when blown glass bursts. In addition sideways displacement and rotation of teeth from constant pressure, fissuring of the enamel and an unusual amount of caries, which he considers due to a high iron content of the saliva from the iron pipe, are common among the workers.

In conclusion he suggests the use of an individual mouthpiece of some softer material to protect mouth infection; the replacement of injured teeth by false ones; and prophylaxis against caries. The problems of abrasion and displacement of the teeth are not at present to be solved. The article ends with an excellent list of references.—J. W. S. Brady.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Le Bouton d'Huile. And Forms of Occupational Acniform Folliculitis. *Paul Blum.* Bull. de l'inspection de travail, 1920 Nos. 3-6, 321-346.—A condition of the skin is described among metal workers in ammunition works in St. Denis, popularly called by the occupier and worker *bouton d'huile*, or oil pimple.

This condition was first described by Purdon of Belfast in 1867 in young girls, cleaning and oiling spindles, and later by Leloir at Lille in 1889 among spinners in cotton mills. The latter thought that it was due to a tarry resinous substance in solution.

In 1901 Dubreuilh described a case of industrial acne due to contact with mineral oil in an iron worker, who plunged metal plates into mineral oil and then carried them to a stamping machine; he considered it a special form of acne and the first stage of a disease of increasing gravity, such as is found in petroleum refiners.

According to Dr. Blum's researches in shell factories and engineering works, the oil is only a vehicle, although the quality of oil is important; soluble oil is harmless, whereas pure mineral oils and lard oil are more harmful than vegetable oils. The disease occurs more frequently where oil is used in abundance and is recovered for further use. The true cause is the dust contained in the oil. The action is mechanical, chemical, and inflammatory, with secondary infection produced by microbes from the dust, from recovered oils, from the skin, and from the worker's clothing.

Dr. Blum proposes to give to this affection the name *follicular elaiokoniosis* (from the Greek words for oil and dust). The onset is slow and first manifests itself in three or four weeks, but occasionally in fifteen days, by moderate itching. At this period papules are rare, but some black specks on the back of the hands and a few scratches on the forearm may be seen. He describes the following stages:

Stage 1.—Follicular punctuation (called by Thibierge "inking" of follicles). The black spots are not superficial and cannot be removed by soap and brush. The typical position is on the dorsum of the fingers, hands, and forearms; but occasionally on the abdomen, as, for instance, when a worker carries a shell; and rarely on the lower limbs, where the rubbing of the trousers soon makes it papular and pustular; and more rarely on the forehead and cheek.

Stage 2.—Pseudo-comedo or "false acne" with hyperkeratosis of the follicular orifice. The black part consists, not of keratin as in true acne, but of a mixture of metallic dusts and inflammatory cells. The typical position is first on the front of the forearm and then on the hands. Iron, chrome, zinc, nickel, and copper have been found in the pseudo-comedo, also staphylococci, and very rarely streptococci, but never coccobacilli.

Stage 3.—Papular perifolliculitis, which is

slightly itchy and of a dull red, violet, or coppery color. The conditions may remain at this stage.

Stage 4.—Papulopustular pus may escape or a boil may form. The different stages are rare in the same subject at one time.

For the purpose of differential diagnosis in various stages the following must be borne in mind: burns from boiling oil, impetigo, scabies, impregnation by coal dust, pityriasis rubra (but this lasts for a long time), true acne, phthiriasis, syphilis, and tuberculosis of the skin, variola, skin lesions caused by drugs (such as iodides and bromides) or by occupation. In connection with the latter he mentions acneiform folliculitis caused by cade oil, beech oil and birch oil, by cement, by distillation of coal tar, especially in paraffin workers, and he asks whether this is due to the paraffin or heavy oils which keep in suspension such irritants as caustic soda.

He discusses chimney-sweeps' cancer, which he says is rarer in France than in England, probably because less coal is used in France and also because it has been subjected to a separation process, and mentions that Bayet was struck by the analogy to chronic arsenical poisoning.

He describes the lesions in so-called chloride acne of makers of chloride of lime or soda by electrolysis, with papules and pigmented spots on the face, neck, trunk, limbs, and scrotum, usually accompanied by gastric and pulmonary disturbances, where the action is internal and external, the chloride being eliminated by the glands and the hypochlorite of soda inflaming the orifice of the sebaceous glands.

The mechanical theory of acne of Virchow and Kaposi is opposed by the French School, on the ground that talc dust rarely gives trouble, and workers in aluminum bronze powders get only an eczematous dermatitis, and workers in sulphur, saltpetre and bisulphide of arsenic do not get acneiform folliculitis.

The treatment of elaiokoniosis is by soap and water, and by careful massage, in order to express the contents of the follicles. The open orifice of the follicles should then be touched with iodine, followed by the application of a lotion containing sulphur, glycerine, and possibly camphorated alcohol, which must be allowed to dry on. For the boils tin oxide may be given internally.

From a medico-legal aspect, everything points to its being an occupational disease and not an accident.

As a preventive measure, wash basins, soap, and brushes should be provided, also clean overalls (preferably impermeable), which should be the property of the workers and should not be passed from one person to another, and there should be a cloakroom. Clean oils should be provided and not used to extinction by continued recovering. Chassevant has persuaded occupiers to wash recovered oil with alkaline solution and to filter it. Dr. Blum lays stress on the value of medical supervision in the factory.—S. A. Henry.

A Form of Industrial Dermatitis. *Allison D. McLachlan.* Glasgow Med. Jour., April, 1922, p. 212.—This dermatosis, caused by the cutting compounds used in engineering works, affected seven out of 200 operatives examined by the writer. He feels sure that not a few other cases escaped his notice and that such cases are frequently overlooked by industrial surgeons, or else are usually grouped under the general heading of septic sores.

The lesions are symmetrical, are seen in the interdigital spaces, on the backs of the hands and the cuff areas of the forearms. They are usually ill defined, slightly raised, infiltrated, itching, red, scaly patches, or may develop as vesico-pustules or bullae. McLachlan finds them most rebellious to treatment unless work is suspended.

On analysis, he found that these cutting compounds consisted essentially of an emulsion of soap, oil (mineral), and water. As the same fluid, by pumping, is made to circulate so as to cool and lubricate certain parts of each machine and then fall into open trays, it becomes freely contaminated. The writer examined the bacterial content of his own samples and gave the recorded findings of other investigators also. He arrived at the conclusion that, at the present time, bacteriological evidence only warrants our belief that the organisms found may be a source of secondary infection which is initiated by the chemical and physical properties of the oil, etc.

Among other observations he emphasizes

the following: That the condition noted arises solely from occupation; that the affection is of more frequent occurrence than is generally supposed; that personal and occupational hygiene are important; that the employees should refrain from using oily rags, and should make use of the conveniences provided for cleansing purposes.—R. Prosser White.

A Case of Apparent Cataract Following Injury with Copper Fragment. *Alois Hanger.* Wien. klin. Wchnschr., 1922, 35, No. 17, 474-475.—The slight clouding of the lens had the sunflower form, grayish color and transparency typical of the copper injuries previously described. There was no direct damage to the lens, and presence of the foreign body within the eye was established. The fragment was not removed and therefore could not be analyzed, but the history of the case, its typical picture, and the fact that it remained inert in a powerful magnetic field indicate that the material was copper.—B. Cohen.

An Occupational Argyrosis of Both Corneas. *Subal.* Wien. klin. Wchnschr., 1922, 35, No. 21, 493.—A patient, 65 years of age, acquired argyrosis of both corneas from brushing silver with a mixture of oil and pumice. The connective tissues of the lower halves of both eyeballs showed a mouse-gray silver impregnation. The corneas, to the deepest layers, were impregnated in the same way. The yellowish tinge observed there suggests that the silver was bound organically.—B. Cohen.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Safety. *H. J. Wilson.* Ann. Rep. Chief Inspect. Factories and Workshops for 1921, Cmd. 1705, 1922, pp. 15-32.—Trade depression is accountable for a reduction in accidents in Great Britain from 138,773 in 1920 to 92,565 in 1921. In the textile trades cleaning machinery in motion is a prolific cause of accident; in all industries "falling bodies" and "persons falling" lead to nearly 40 per cent. of serious cases. Owing to the action of inspectors, the standard of fencing danger-points has risen, and some forms of accident, formerly common—as, for instance, those on the tin rollers of ring frames—have practically ceased. Safety committees are slowly spreading and doing good work; at one large mill by efficient organization a loss in 1920 of 4,235 days through accidents was reduced to 1,225.5 days in 1921.

Reference is made to an ingenious device for locking the setting-on rod of cotton mules, and to an air suction feed arrangement for platen printing machines. Accidents on power-presses in metal work were specially investigated; the inquiry shows the large proportion due to personal carelessness either on the part of the operator or, on account of lack of efficient guard, on the part of the employer, and the small proportion of unavoidable accidents. Another inquiry into accidents at bakers' dough machinery showed that makers of such appliances were still satisfied to send them out imperfectly guarded; hence accidents on trough machines remain as numerous and serious as in pre-war days. On the other hand, builders of cranes are found to be fully alive to the need for sending out cranes fitted with the newest safety devices, so that now only an old and primitive plant gives trouble. The same thing applies to hoists, of which unfortunately many antiquated specimens exist.—E. L. Collis.

Industrial Accident Reporting. *Charles H. Verrill.* Am. Labor Legis. Rev., March, 1922, 12, No. 1, 67-68.—"It may be stated without hesitation that except where a workmen's compensation law is applicable, complete accident reports cannot be secured and should not be expected." Experience has shown that employees oftentimes will not make a report of an accident, or the employer does not make a record of an accident reported unless the injury seems to be immediately serious or unless there is some financial motive. Failure of laws requiring accident reporting, which existed before the enactment of workmen's compensation statutes, the incompleteness of the reporting of short-time accidents causing disability for which no com-

pensation is payable, and the failure of laws respecting reporting of occupational diseases show what is to be expected. Even where workmen's compensation laws have been enacted, accidents may not be reported for several reasons: Many industries are not covered by the compensation law; many states exclude from the compensation law employers with less than a specified number of employees; short-time accidents are not covered by the law in most states—a provision which greatly restricts the number subject to compensation.

"This absence of accident reporting is particularly unfortunate in that it limits accident prevention work by withholding knowledge of the location, nature and extent of accident hazards."—G. E. Partridge.

Metal-Mine Accidents in the United States during the Calendar Year 1920. *William W. Adams.* U. S. Bur. Mines, Tech. Paper 299, 1922, pp. 99.—This pamphlet is a compilation of the accident statistics for all metal mines in the United States during 1920, showing causes and distribution of accidents. —M. C. Hamblet.

Quarry Accidents in the United States during the Calendar Year 1920. *William W. Adams.* U. S. Bur. Mines, Tech. Paper 295, 1922, pp. 66.—This pamphlet has been compiled from reports received directly from operators of quarries, and represents all processes of the quarrying industry. The statistics are thoroughly representative, although perhaps not complete for the entire industry. Special tables are presented to show accident rates at quarries producing stone, and at those producing crushed stone. Special tables also show the causes of accidents attributed generally to the use of explosives, haulage equipment and machinery.—M. C. Hamblet.

INDUSTRIAL SURGERY

Corrective Measures in Disabilities of the Back. *W. B. Fisk.* Nation's Health, May 15, 1922, 4, No. 5, 297-299.—In seven of the eleven patients, whose case reports Dr. Fisk presents, the pain was localized about the left sacro-iliac joint; in three, about the right sacro-iliac; and in one, over the fifth lumbar vertebra. Two of the patients had pain for several months before deformity was noticed.

The treatment which was applied "consisted in complete relaxation under anesthesia, and with the patient lying on his back with shoulders fixed a slow, strong pull is made on the legs. The pull is steady, and is equal to a lift of seventy-five to one hundred pounds. In making the pull, the ankles are grasped by the operator. I usually place one foot against the table in order to exert a strong pull. I then turn the patient on his abdomen and with my helper working on the opposite side, I thrust my arm under the knee of the patient, with the forearm hooked over the lower part of the thigh. My other hand rests on the sacro-iliac joint. The patient's thigh is then drawn downward and at the same time is over-extended on the body while the sacro-iliac joint is pressed forward.

"I never use fixation appliances of any kind after the stretching operation."

"The deformity and pain in the back have been corrected in ten out of the eleven patients worked on. In six . . . the patient after a disability of from a few weeks to four months has returned to work within a week after the stretching, and has continued at work without interruption. In three cases the pain and deformity in the back were corrected by the stretching, but some discomfort over the outer part of the calf and sole of the foot persisted. In one case the pain and deformity were relieved by the stretching. This patient returned and continued at work for six months, when the deformity recurred.

"In one chronic case where there was no perceptible deformity, the stretching proved of little value. This was in reality a test case. I was desirous of knowing if the stretching process would prove of value in cases where there was no deformity."—M. C. Shorley.

Lesions of Nerves in Arms. *H. Abrahamsen.* Abstracted as follows from Ugesk. f. Laeger, March 30, 1922, 84, No. 13, 295, in Jour. Am. Med. Assn., May 20, 1922, 78, No. 20, 1582.—"Abrahamsen says that cutting wounds were responsible for the injury in thirty-seven of his fifty-two cases of lesions of the nerves in the arm. This is the most frequent cause of paralysis of the arm in

adults, an open cut from a knife or piece of glass. Fractures seldom induce paralysis. In children, subcutaneous injuries are more common, and secondary paralysis is frequent. This may be due to the lesser resistance of the youthful nerves or to the extreme dislocation of the fragments which is common, but over-exuberant callus is the most frequent cause of nervous disturbance in children. It is necessary therefore to distinguish between lesions in children and in adults. He emphasizes the importance in all injuries of the arm near the trunk nerves of making a thorough examination before the operation, before conditions are modified by the anesthetic. Too often the injury to the nerve is overlooked until after the incision has been sutured. The end-bulbs have to be resected before the nerve can regenerate. In only nine of the thirty-seven cutting wounds had the nerve been sutured primarily, while in all the others (75 per cent.) the injury of the nerve had not been discovered until local anesthesia, chilliness, cyanosis, advanced atrophy or contracture had called attention to the fact that the nerve had been injured. The functional damage resulting from this oversight of the nerve lesion is often serious for handicraftsmen, as he shows by several examples, the disability compensation amounting finally to 20, 30 or 40 per cent."—C. K. Drinker.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Alcohol and Industrial Efficiency. *H. M. Vernon*. Brit. Jour. Inebriety, 1921, 18, 109-123.—(*Review by author.*) The effect of alcohol upon manual dexterity is very greatly influenced by the time at which it is taken, in relation to meals. Experiments were made systematically in which a whiskey mixture containing 45 c.c. of ethyl alcohol was taken directly after a substantial meal, or from one to twenty hours afterwards. The influence on speed and accuracy of typewriting was measured, and the deleterious effect of the alcohol taken directly after food amounted to 1.7 per cent., while it was 2.5 and 2.9 per cent. when taken respectively one and two hours after eating. When taken three and one-half hours after a meal, the effect was 7.6 per cent., or more than twice as great as before, owing to the fact that the stomach was practically empty of food. After intervals of thirteen and twenty hours the effect rose to 9.8 and 10.2 per cent. Fatigue increased the effects produced, for a two-hour bicycle ride at the end of a thirteen hours' fast increased the typing mistakes made to 19 per cent. more than those made in the corresponding resting experiments.

The effects produced by 30 c.c. of alcohol disappeared in about two and one-half hours, and those produced by 15 c.c. and 60 c.c. in three and one-half hours and four and one-half hours, respectively. These results indicate that alcohol was being oxidized in the body (body-weight 76 kg.) at the rate of about 13 c.c. per hour.

Health Problems Involved in Noise and Fatigue. *Henry J. Spooner*. Nation's Health, Feb. 15, 1922, 4, No. 2, 91-95.—Apart from muscular fatigue, the output of a worker is primarily affected by the quality of the air in which he works, the efficiency of the lighting arrangements, and the amount of noise in his vicinity. Although fatigue resulting from noise attacks primarily the ear, it little by little extends to the whole nervous system, in some cases causing even greater weariness than that due to muscular fatigue. Medical authorities are agreed that noise is injurious to health, and is an undoubted source of fatigue and nerve strain, due chiefly to its influence upon the faculty of attention. Noise is also the greatest enemy of sleep.

The author gives a brief description of the ear, makes some remarks upon hearing and deafness, and draws attention to the fact that men working together instinctively tend to work rhythmically. Some of the best known ear protectors are described; certain truths regarding the origin and propagation of sound are considered; and finally the primary kinds of noise that demand attention are classified.—L. A. Shaw.

WOMEN AND CHILDREN IN INDUSTRY

SHORTCOMINGS IN CHILD PROTECTION. *Ethel M. Johnson.* Am. Child, May, 1922, 4, No. 1, 49-52.—There are many conditions of child life in Massachusetts still in need of correction. There is a high accident rate among working children, and young children are at work in the agricultural fields. Massachusetts is falling behind some of the more progressive states with regard to educational standards. Within a year or two continuation schools have been established for children 14 to 16 years of age; whereas in several states continuation school attendance is required of all working children up to the age of 18 years, and for eight hours a week, as compared with the four-hour minimum in Massachusetts. Of children under 16 who go to work, nearly nine-tenths enter occupations that have little or no educational value. Job shifting is very frequent among the younger workers.

Efforts are made to safeguard children entering industry by requiring them to meet certain minimum standards as to age, education, and physical fitness. There are restrictions upon the processes and occupations at which young persons may work. But there are practical difficulties and limitations in extending this protection. The examination for physical fitness may be superficial or may be omitted entirely; and as this work is now performed few children are excluded from industry because of defects. It is difficult to confine children to the safe areas in industry, partly on account of the ease with which a worker may be changed from one kind of work to another, and partly because of the natural tendency of children to be careless and to disregard rules. Children are tempted to try to operate machinery to which they are not assigned, and the fault is therefore the child's, but indirectly the fault rests with the society that permits children to be in industry at an immature age.—G. E. Partridge.

INTERNATIONAL CHILD LABOR LEGISLATION. *Raymond G. Fuller.* Am. Child, May, 1922, 4, No. 1, 34-38.—The draft conventions of the third general conference of the International Labor Organization of the League of Nations, which was held at Geneva last fall, contain several articles affecting the labor of children. It is provided that children under the age of 14 may not be employed in any public or private agricultural undertaking except outside the hours of school attendance; and that for the purposes of practical vocational instruction the periods of the hours of school attendance may be so arranged as to permit the employment of children on light agricultural work, provided that such work shall not reduce the total amount of school attendance to less than eight months a year.

Several recommendations were made: that every member of the organization try to develop vocational agricultural education; that steps be taken to regulate the employment of children under the age of 14 at night work in order to give not less than ten consecutive hours of rest; and of young persons from 14 to 18 so as to provide not less than nine consecutive hours. Measures to protect women wage earners employed in agriculture were advised. A draft convention was adopted fixing the minimum age for the admission of young persons to employment as trimmers or stokers on vessels at 18 years (with certain exceptions). Another convention provides that the employment of young persons under 18 on any vessels other than those upon which only members of the same family are employed shall be conditional on the possession of a proper medical certificate.

British Columbia, Belgium, Czecho-Slovakia, Great Britain, Greece and Roumania have accepted the draft convention fixing the minimum age of admission to industrial employment. The Washington convention relating to night work of young persons has been adopted by British Columbia, Belgium, Denmark, Great Britain, Greece, and Roumania. Great Britain, Germany, Italy, and Sweden have passed measures ratifying or giving effect to the Genoa draft convention fixing the minimum age for admission of children to employment at sea.

"It should be noted that although the first International Labor Conference was held in Washington and the International Labor Office has an American correspondent, the United States is not a member of the League of Nations and therefore, of course, does not participate in the affairs of the International Labor Organization as a member nation."—G. E. Partridge.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Health and Sanitation. *E. A. R. Werner.* Ann. Rep. Chief Inspect. Factories and Workshops for 1921. Cmd. 1705, 1922, pp. 55-61.—Mr. Werner summarizes the situation in British factories in relation to cleanliness, ventilation, temperature, illumination, and dust removal. Slackness of trade is giving opportunity for cleaning and limewashing—an economy with regard to illumination; a novel and easily cleaned floor is referred to, composed of concrete as a foundation for machines, and asphalt for passages and alleyways; lack of cleanliness in food factories, particularly in bakehouses, is criticized and the need for exterminating flies is stressed. Bakers seem adverse to cleaning by water which cools the atmosphere and consequently checks fermentation, but there is no reason why properly constructed floors should not be frequently scraped. Progress is reported in the installation of enclosed apparatus—conveyors and elevators—for suppressing dust, and of localized exhaust ventilation for its removal. The substitution of manufactured abrasive wheels (containing little or no free silica) for ordinary sandstone wheels is welcomed as minimizing the dust danger. In the textile industries dust removal in the opening processes and in carding continues to be improved, and the devices used are being extended to many other industries. Attention to general ventilation lags behind, owing to lack of appreciation of the need and of expert knowledge as to means to adopt it. Temperature is better understood; means for cooling men at unduly hot work by air douches, and better provision for warming chilly workrooms are reported; more enlightened views are gaining ground. On the other hand, surprisingly little attention is directed to illumination, having regard to its undoubted economic value; obsolete batswing gas burners still prevail, and in many fustian-cutting works the operatives still have to provide their own candles.—E. L. Collis.

Labor Camp Sanitation in California. *R. Justin Miller.* Nation's Health, Feb. 15, 1922, 4, No. 2, 96-101.—The Camp Act in California lays down certain rules and regulations which must be observed by the operators of workingmen's camps in that state in order to insure proper sanitation and a reasonable healthful environment for the workers. The law calls for suitable bunks or beds with an adequate supply of fresh air for each person; certain regulations must be observed with regard to the food and the manner in which it is cooked and served; bathing facilities, toilet construction, drainage, and sewage must conform to very definite specifications.

The enforcement of this act is in the hands of the Commission of Immigration and Housing of California. Inspectors are sent out by the Commission and assigned to definite sections, checking up the conditions which they find. Their reports are sent to the main office and instructions are despatched to the camp operators informing them of necessary changes to be made. The system has proved a great success.—L. A. Shaw.

Underground Workrooms. *H. Martindale.* Ann. Rep. Chief Inspect. Factories and Workshops for 1921. Cmd. 1705, 1922, pp. 95-107.—This article summarizes the conditions found in London in three hundred underground workrooms of all sorts and kinds in which a great variety of trades were being carried on. The more modern premises were of semi-basement type with ceilings above the street level; but the older ones, never intended for use as workrooms, presented structural conditions impossible for good lighting, ventilation, and general hygiene. In some instances the only provision for ventilation consisted in holes pierced in pavement lights; in other cases fire flues carried off foul air fairly efficiently; while in 7 per cent. mechanically driven exhaust or inlet fans were installed. In some cases air movement only was effected by open fans; but in only 19 per cent. of the premises visited was through ventilation impossible. The state of the air, as determined by carbon dioxide content and by kata-thermometer observations, although far from ideal, was found less unsatisfactory than might have been anticipated.

Lighting during daylight hours was not good, and in 78 per cent. of the rooms natural light was insufficient and required at all times to be supplemented by artificial illumination; in several cases practically no natural light whatever entered the rooms. Electric light was the usual illuminant; but too often unshaded lamps were in use instead of indirect general lighting, and glare resulted. Obstruction of windows by machinery and packing cases, and lack of attention to cleaning, reduced the natural light in the majority of rooms.

Heating appliances were quite haphazard, and frequently a heat-producing plant was relied upon for warmth.

The general conclusions drawn from this comprehensive inquiry, which establishes a standard for present-day conditions of work, are that on the whole the standard maintained is better than might have been anticipated and far higher than existed in such unsuitable premises a few decades ago.—E. L. Collis.

Lighting the Factory. *S. G. Hibben.* Factory, May, 1922, 28, No. 5, 523-526.—Outdoor illumination is many times greater than even the highest estimates of what constitutes good artificial lighting indoors. Within a building natural illumination varies greatly from place to place. The result is that there are inequalities in light subject to recognizable laws which the illuminating engineer must take into account. Lighting problems are complicated by the position of buildings and their direction of exposure, etc. Distribution of light may be effected by the use of curtains and by proper employment of prism window glass. The study of daylight involves also a study of color, since natural light is very changeable in its hues. Finally, the cost of artificial lighting as related to the cost of construction and maintenace of the means of utilization of natural light must be taken into consideration.

The present paper touches only briefly upon the phases of illumination that are presented, but there are several useful charts showing the intensity of daylight at different periods of the year and hours of the day; the lighting values at sunset; effect, with regard to interior daylight illumination, of the orientation of the illuminated spaces; comparative brilliancies of various illuminating means; transmission through sheet glass; and radiant energy of lights of different colors.—G. E. Partridge.

Research Work that Solved the Problem of Ventilating the Hudson River Tunnel. *Robert G. Skerrett.* Reprinted from Compressed Air Mag., April, 1922, in Heating and Ventilating Mag., May, 1922, 19, No. 5, 29-35.—This is a review of the research on the engineering and physiological aspects of ventilating the Hudson River vehicular tunnel. Interested readers are referred to the article by Henderson and others, entitled "The Physiological Effects of Automobile Exhaust Gas and Standards of Ventilation for Brief Exposures," which appeared in this Journal, 1921-1922, *3*, 79, 137.—Philip Drinker.

Determination of the Relative Comfort of Mine Working Places by Means of the Kata-Thermometer. *D. Harrington* and *G. E. McElroy.* U. S. Bur. Mines, Rep. Investigations, Ser. No. 2355, May, 1922, pp. 7.—Some data have been collected by the United States Bureau of Mines and the United States Public Health Service relating to the adaptability of the kata-thermometer for determining the comfort of working places in mines. The kata-thermometer is an instrument devised by Dr. Leonard Hill, an eminent English physiologist, for the purpose of measuring the rate of cooling of the human body. It measures its own rate of cooling when its temperature approximates that of the human body, and so measures comfort which, in Hill's opinion, is controlled by the rate of cooling. The instrument does not measure other vital elements such as chemical impurity and the presence of various kinds and quantities of dust, but the substitution of "kata" cooling powers for the wet-bulb air temperature is an advance. Recently there has been put on the market an electric kata-thermometer, by which dry cooling powers may be read directly.

Comfort felt in air having particular cooling values depends in part on the individual and his physical condition and upon the kind and amount of clothing worn, but it is possible to show the relation of definite limits of cooling power to degrees of comfort. The

cooling power of air has a direct relation to a worker's efficiency. For this reason, one of the important problems in the metal-mining industry of this country is to provide such air conditions at working faces as will permit the miners to work comfortably, efficiently and without straining the heat-regulating mechanisms of the body by excessive perspiration. Factors of temperature and humidity are difficult to control, but air movement, the most important factor in producing cooling power of the air, is controllable. At the present time the conditions in regard to this factor are poor; air-movement, even in the better ventilated so-called hot mines, is almost wanting at most working faces, especially in development ends, and the same is true of too many fan-pipe ventilated development ends. Better conditions for the comfort of mine working places in our metal mines can be effected by more attention to providing air motion at the working faces.

The paper contains two useful tables: Table 1 shows the relation between cooling power of the air and comfort; Table 2 presents data in regard to six typical mines with reference to measurements by the kata-thermometer.—G. E. Partridge.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

First Aid. *S. D. Hubbard.* New York Med. Jour., Jan. 4, 1922, 115, No. 1, 36-39.—Industrial hygiene comprises many functions which may be included in the following twelve groups: (1) prevention of accidents in industrial establishments and application of the principle of safety first; (2) prevention of disease in industrial establishments (including communicable diseases, diseases of degeneration, and the special diseases of occupation); (3) elimination of nuisances (referring to disposal of garbage, waste, fumes, dust, and smoke); (4) maintenance of heating, lighting, ventilating, etc.; (5) providing and serving suitable food, and inculcating proper diet habits; (6) installation and management of dispensary and hospital service; (7) keeping statistics of accidents, diseases, absences, and facts regarding new employment and dismissals, and making special reports and suggestions for improvement of the service; (8) supervision of fire prevention, fire drills, first-aid instruction, inspection for safety, teaching the special hazards of an establishment, prevention of dangers of such incidence; (9) education in personal hygiene and sanitation in the shop, the home, and the community; (10) special research such as may be necessary to prevent accidents, preserve health, increase efficiency, and improve safety; (11) supervision of clothing and selection of glasses; (12) efforts to discover the causes of fatigue, and to determine its presence; provision for games, rest rooms, physical training, locker room, and cleaning facilities.

First aid is not instinctive, but is an acquirement and should be taught to all employees. Bulletins, literature, talks, motion pictures and other methods should be employed in facilitating its dissemination. The co-operation of all must be gained, and the appreciation and assistance of everyone in the plant are needed. "First-aid instruction and installation must therefore be done so intelligently and humanely as to make all appreciate the danger of accidents and the necessity of keeping them down to the lowest number possible. . . . . First aid is something more than simply opening a small office and caring for the injured."—G. E. Partridge.

Prevention Work Is Emphasized. *C. W. Geiger.* Hosp. Management, April, 1922, 13, No. 4, 56.—As part of a personnel program, the Paraffin Companies, Inc., of San Francisco have installed complete medical service. Physical examinations of the employees are being made in order to protect their health. Dismissal does not follow discovery of ill health, but an effort is made to place an affected person in a position where his work will be favorable. First aid is taught to all employees in the plant, and it is of the greatest possible service in preventing sickness.—G. E. Partridge.

Records of the Small Sick-Benefit Association as a Source of Statistics for the Factory Medical Department. *D. K. Brundage.* U. S. Pub. Health Ser., Pub. Health

Rep., Feb. 24, 1922, 37, No. 8, 413-422.—Useful information has been acquired, pointing out the advantages of employee sick-benefit association records. One association, consisting of employees of four manufacturing plants, gives the number of days lost from sickness and non-industrial accidents for five days or longer, during 1920, as 4.68 per employee. This high ill-health rate shows the need for action for correcting whatever conditions there are either wholly or partially responsible for the disability.—M. C. Hamblet.

HEALTH PROBLEMS AFFECTING INDUSTRY. *W. F. Dearden.* Welfare Work, March, 1922, 3, No. 22.—The author presents a short account of the work of Ramazzini in industrial medicine, illustrating the importance attached to the subject in European countries at the beginning of the eighteenth century. He also describes the development of the medical side of the Factory Act and its administration. Both general mortality figures and mortality figures for specified diseases are quoted in order to establish the fact that, in certain trades, "the excessive amount of disability and loss of life from sickness among those engaged in industrial occupations is appalling, and can only be accounted for (*i. e.*, the excess) by the association of deleterious conditions with the industries themselves."

Reorganization, with certain modifications, of medical work in factories according to the plan of the Belgian Factory Medical Department is advocated. —E. Hewitt.

SELLING BETTER HEALTH TO NATIONAL CASH REGISTER EMPLOYEES. *F. G. Barr.* Nat. Safety News, June, 1922, 5, No. 6, 17-19.—The account by Dr. Barr of the National Cash Register Company hardly gives sufficient emphasis to the remarkable results of the health work done under his direction. The average time lost by industrial workers on account of sickness is variously estimated at from six to nine days annually per employee. In the National Cash Register Company the figure is now 11.5 hours. Industrial executives recognize that a company loses heavily when production is interrupted through the sickness of employees. The same methods of prevention used so effectively by Dr. Barr can be used by any other company.

"SELLING" INDUSTRIAL HOSPITAL SERVICE. Hosp. Management, March, 1922, 13, No. 3, 56-57.—The writer emphasizes the importance of publicity in connection with the hospital work of industrial plants. The case reported is of a large increase in the number of employees treated after the beginning of the publication of a bulletin. In 1915, the year before the publicity work was started, the number of cases treated at the hospital, involving no loss of time, was 651, but in the following year there were 1,383 treatments. There were 193 days lost through injuries in 1921, compared with 906 days in 1911, the first year of the hospital. The change has been brought about by persistent advertising of the hospital service.—G. E. Partridge.

WHAT A DENTAL CLINIC CAN DO IN YOUR FACTORY. *L. G. Grace.* Factory, April, 1922, 28, No. 4, 405-407.—Industrial organizations are fast beginning to realize that the dental dispensary is an important factor in increasing the amount of work an employee can do in one day. In one factory the dental work has saved the employees 2,000 hours in the past six months. The work is of two kinds: emergency and preventive. Men with aching teeth will have the pain stopped, but many employees do not realize the serious effects resulting from lack of care of the teeth.

The Metropolitan Life Insurance Company, which has made a thorough study of health conditions in their relation to mental and physical efficiency, has maintained a dental clinic since 1915. The improvement in health of employees has been so marked that, as a result, a rule has been made that every home-office employee must undergo an examination and a cleansing of the teeth twice a year. Other instances are given showing the advantages of dental clinics both to employer and employee.—M. C. Hamblet.

INDUSTRIAL PERSONAL AND COMMUNITY HYGIENE: HOUSING, ETC.

HEALTH IN INDUSTRY AND ITS RELATION TO THE COMMUNITY. *J. G. Cunningham.* Pub. Health Jour., March, 1922, 13, No. 3, 114-117. —This is a very general survey of the subject

of public health, touching upon the development of public health service from its original narrow limit of preventive work. The scope of industrial hygiene is considered; also the problem of infant mortality as related to the employment of women; the problem of "industrial birth"—that is, the change of the school child into the industrial worker; the industrial medical service; part-time medical supervision. The advantages and disadvantages of co-operative effort on the part of small industrial establishments in supplying health service essential in industry are discussed.—G. E. Partridge.

Housing. The Credit Bureau for Industrial Housing. Abstracted as follows from L'Usine, Paris, April 1, 1922, in Factory, June, 1922, 28, No. 6, 651.—"The action of this bureau, which was created by the association of metallurgical industries, constitutes in many respects a happy solution of the industrial housing question in France.

"This organization's object is, while furnishing to manufacturers the necessary capital for workmen's houses—money which the Government would not and cannot furnish—to make of employee housing not a work of charity but a remunerative enterprise for the invested capital, represented by securities negotiable on the Bourse and having solid guaranties. This point of view has been lacking until now.

"After an agreement with large financial houses which have accepted the commission of placing the securities issued, the bureau lends the capital thus raised for periods ranging from twenty to thirty years to the building societies of industrial organizations interested. The heads of the industrial enterprise are always called upon to guarantee personally the loans made, and this eliminates the costly mortgages which the bureau does away with to keep the cost low. House plans must be submitted to the bureau, and all plans must be satisfactory from the point of view of health and sanitation.

"Large families are favored by adequate houses set aside at lower rents than are charged for families without children. Gardens are provided; and since the proprietor is not the head of the manufacturing plant, but a separate organization, difficulty between employee and employer cannot occur as a result of their relation of tenant and landlord.

"The capital, starting at 5,000,000 francs, has grown to 100,000,000 francs. . . .

"One result has been the development of standardized types. Manufacturers who have guaranteed reduced prices on construction materials in lots have been given credit to enable them to undertake quantity manufacturing of these materials. This has been extended to the mill work, sanitary supplies, glass, paints, roofing, heating, and other supplies, and it is estimated that several million francs have been economized in this manner."

Government Aid for the Building of Workmen's Houses in Spain. U. S. Bur. Labor Statis., Month. Labor Rev., May, 1922, 14, No. 5, 166-167.—To alleviate conditions arising from the housing shortage in Spain, a royal decree was issued in 1921, providing for government aid to societies formed for the purpose of building workmen's homes.

According to this decree, the state, province, or municipality may rent, sell, or give away any of its land as a site for workmen's houses, and city councils may purchase land for this purpose. To encourage building operations, many forms of government taxes—taxes on building construction, the purchase of land, contracts, bond issues, formation of companies, etc.—are waived for a period of twenty years from the date of completion of a building. In special cases materials for building workmen's homes may be exempt from customs duties. Government loans with a thirty-year limit may be made, yielding 3 per cent, or even as little as 2 per cent. The maximum loan is limited to 55 per cent, of the value of the land and 70 per cent, of the value of the completed houses.

The government may grant subsidies amounting to 25 per cent, of the value of land and buildings, and one of 50 per cent, if, in cities where the housing problem is very acute, workmen's houses are completed within a year of the publication of this decree.

The royal decree of 1921 also deals with the legal status, rent, interest and security for loans, inspection and sanitation of "cheap" houses, etc. The provisions of the decree are to be administered by the Ministry of Labor through the Institute of Social Reform. The local administration is in the hands of a council on cheap houses in every municipality concerned.—M. C. Hamblet.

INDUSTRIAL INVESTIGATIONS AND SURVEYS

An Investigation into the Packing of Chocolates (2). *B. Muscio* and *R. St. C. Brooke*. Journal Nat. Inst. Indust. Psychol., 1922, 1, 68-75.—The authors describe the effects of training five inefficient girls in the principles of chocolate packing. These principles consisted in the systematic arrangement of materials in such a way as to reduce to a minimum the range and number of a worker's movements, and in instructing her to work with both hands in a rhythmical, easy manner. After four or five weeks' training by a skilled packer, who was chosen as instructor, the efficiency of the girls showed an average increase of 27 per cent.

Subsequently, twelve novices, of average general ability, were trained for seven weeks, and it was found that their speed of packing was nearly 27 per cent. greater than that of other novices who, in accordance with the usual custom, had received no systematic training.

The authors point out that skilled workers are by no means always good instructors. Their movements are usually too rapid to follow, and as they are semi-automatic the workers themselves may not know of what they consist.—H. M. Vernon.

A Survey and Analysis of the Pottery Industry. Fed. Board for Vocational Education, Trade and Indust. Series No. 20, Bull. No. 67, pp. 86.—The writer first indicates briefly his procedure and makes some pertinent suggestions about the uses of such a bulletin as he has prepared—by the employer to gain a "bird's eye view" of his industry; by the foreman as a handbook in giving instruction; by the workman as a description of his job in its relations to the industry as a whole; by the director of vocational training, etc.

The main part of the report is a study in job analysis. The different departments of the pottery industry are taken in turn, and data are given in regard to possibilities for training, lines of promotion, qualifications necessary, including skill, education, physical qualities, age, etc. The jobs are then considered again with reference to such topics as trade terms, stock, care of tools and equipment, safety, and requirements in regard to mathematics, science, and drawing.

The art work of pottery is treated separately by a similar procedure, and the report includes a sketch of the general trade science relating to the industry.—G. E. Partridge.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

Health Legislation in Belgium. Survey, March 11, 1922.—There is an important new anti-tuberculosis act in Belgium, making state support available to private organizations. A new national association has been formed which is entitled to a grant of several million francs. Large sums have been given from the first grant to a co-operative organization for the establishment of sanatoria. Dr. Glibert, director of the Bureau of Hygiene in the Department of Labor, is enthusiastic over the prospect, as he sees it, of making Belgium the model country in the prevention of the white plague.

Dr. Glibert has been giving attention, also, to the drafting of a law for insurance against industrial diseases not covered by the present sickness insurance. Under the latter, compensation of one-half salary is allowed, but Dr. Glibert thinks that the responsibility of the industry in the case of lead poisoning, anthrax and similar definitely industrial diseases should be greater, perhaps to the extent of compensation to the full amount of the normal earnings. Under this bill, the principal contributions will fall on employers, with smaller grants from state and province. It does not provide for reinsurance of employers, but for contributions large enough to make a reserve fund.

There are plans for providing state supervision over the health of juvenile workers. The department already has power to issue certificates to apprentices from 14 to 18 years of age, and a royal decree has been issued to the effect that all such apprentices must be medically inspected at least once a year. There is gradually being organized a coördinated system of state supervision in the form of medical inspection for schools, military serv-

ice, apprenticeship, and certain state and municipal institutions. A further extension of the principle is advocated for the protection, by medical care, of expectant mothers in industry. Obligatory provision of first-aid equipment in factories has recently been enacted.—G. E. Partridge.

Regulations: Lead Compounds. Internat. Labour Office. Legis. Series, Great Britain, No. 6, 1921.—This pamphlet gives regulations for the manufacture of certain compounds of lead in Great Britain under the two headings: (1) duties of occupiers, and (2) duties of persons employed.

Act Providing for Erection of Washrooms for Employees Held Invalid. U. S. Pub. Health Ser., Pub. Health Rep., April 8, 1922, 37, No. 17, 1021.—Section 1 of Chapter 20 of the 1920 acts of Kentucky required certain employers to provide and maintain washrooms when 30 per cent. of the employees had voted to notify the employer to erect such a washroom. This act has been declared unconstitutional by the Court of Appeals of Kentucky on the ground of its being a delegation of legislative power in violation of Section 60 of the state constitution.—B. Cohen.

Hours of Work in German Industry. Abstracted in Internat. Labour Rev., May, 1922, 5, No. 5, 784-798, from Report of Netherlands Commission of Enquiry into Hours of Work in German Industry.—The German order limits the working day in all industrial establishments to eight hours. No weekly limit is fixed, but since 1895 Sunday work has been prohibited for workers in industrial establishments, with certain specific exceptions. No provision is made for a Saturday half-holiday, but it has been generally adopted by agreement. Night work for adult men is not prohibited, but work between 8 P. M. and 6 A. M. is prohibited for women and for persons under 16 years of age. The use of the two or three shift system is not restricted in the case of adult workers. Authorization for overtime work is often granted, especially when foreign orders are involved, and when conditions necessitate it.

The report deals with administrative provisions, and with hours of work in the following industries: glass and pottery, printing and book trades, chemical industry, wood working industry, clothing, leather, metal working, textiles, beet sugar industry, and bakeries.—G. E. Partridge.

Decisions of Courts and Opinions Affecting Labor. 1919-1920. *Lindley D. Clark* and *Martin C. Frincke, Jr.* U. S. Bur. Labor Statis., Bull. No. 290, Jan., 1922.—This bulletin is the eighth of a series devoted exclusively to the presentation of court decisions. No attempt is made to cover the entire list of decisions handed down by the state and federal courts, but representative types have been selected.—M. C. Hamblet.

Some Remarks Concerning Compensation for Ocular Injuries. *F. Allport.* Med. Record, March 18, 1922, 101, No. 11, 446-451.—State industrial commissions have demonstrated their own usefulness, but it is contended that they should be chosen with reference to avoiding partisanship, and should not predominantly include men in either the employer or employee class.

The medical expert meets a number of difficulties in his relations with these industrial boards. Verdicts are often given in contradiction to plain medical evidence, as in cases in which compensation is claimed for troubles that could not have arisen from an injury, and in cases in which malingering is demonstrated. There is a law concerning visual losses that is most unfair and illogical to all parties concerned—that is, if a man who is already blind in one eye loses the other eye while in employment, the employer is liable for the loss of both eyes. The man with but one eye is a greater risk, and consequently many men are debarred from desirable occupation because unjust responsibilities are forced upon employers.

The subject of traumatic cataract raises other questions. Industrial commissions as a rule insist upon estimating vision in such cases without glasses, the result being that since the employer gets no credit for the results of a successful operation by which the vision may be practically restored, he is tempted to discontinue the treatment without providing for a desirable operation. The alternative would be for industrial commissions and legislatures to allow an employer some reasonable financial consideration if he undertakes the expense of a cataract operation.

Another point to be insisted upon is that employers and applicants demand examination of eyes and ears before employment.

It must be the experience of all surgeons doing any amount of industrial surgery that many employees endeavor to represent that old pathological conditions have never existed until some recent accident has occurred. Old necrotic conditions and senile cataracts are charged to such injuries.

One obstacle to just and intelligent settlement is an absurd but natural interpretation of Snellen's test types. Testimony is often given that 20/40 indicates a half loss of vision. The writer offers a new table which eliminates the possibility of wrong conclusions being drawn by regarding the Snellen fractions as indicative of visual conditions and which also overcomes some of the practical deficiencies of the scale accepted by the Chicago Ophthalmological Society in 1919, which has discrepancies in percentages, making its general adoption difficult to attain. The new scale is as follows:

20/20	indicates	no	loss	of	vision.
20/30	"	5%	"	"	"
20/40	"	10 "	"	"	"
20/50	"	15 "	"	"	"
20/190	"	85 "	"	"	"
20/200	"	90 "	"	"	"
20/210	"	95 "	"	"	"
20/220	"	100 "	"	"	"

—G. E. Partridge.

Rating Losses of Industrial Vision Under the New York State Compensation Law. *W. Mehl.* Med. Record, Jan. 28, 1922, 101, No. 4, 145-148.—Permanent disability compensation bears no direct relation to the damage done to the earning ability of an injured person, but attempts to provide for average industrial justice. The law of New York state, for example, takes no account of the actual economic losses in compensating for permanent disability in eyesight caused by industrial injury.

The function of the examining medical expert ought to end with an exact estimate of the injury sustained. In other fields the surgeon is not usually requested to interpret his results with reference to the compensation law as he is frequently requested to do in regard to injuries involving impairment of eyesight.

Ordinarily loss of vision may be determined by the Snellen tests, even though they apply only to central vision. The law now provides that a loss of 80 per cent. of vision is to be regarded as loss of use of an eye. This means that vision is 20/100 of normal and the Snellen test has been accepted as a means of measurement. In regard to vision between normal and 20/100, 20/40 means that working vision has been reduced to one-half normal. Looking at the matter from the standpoint of industrial efficiency, it may be conceded that 20/40 represents less than 50 per cent. impairment of vision. By accepting 20/100 as 100 per cent. loss, and dividing the interval, 20/60 is found to be 50 per cent. loss of vision, and the percentages of reduction for other measurements are proportionate.—G. E. Partridge.

Japanese Health Insurance Law. U. S. Dept. Labor, Month. Labor Rev., July, 1922. 15, No. 1, 164.—"A special report from the acting commercial attaché at Tokyo, Japan, summarizes the provisions of a health insurance law recently passed by the Japanese Diet. The text of the law consists of 91 articles but in brief it provides that employees in factories of every description, both official and private establishments, shall carry health insurance if their annual income is 1,200 yen ($598.20, par) or less. The health insurance law is to be administered by the Government and the insurers are to be the Government and organized health insurance societies. These societies are to be organized by factory proprietors and their employees and one-tenth of the expense of said societies is to be borne by the Government.

"The insurance premium, which must not exceed 3 per cent. of the daily wage of the employee, is paid half by employers and half by the employees. Insurance is paid to employees in case of sickness, accident, death, and childbirth."

Compulsory Health Insurance. A Connecticut Viewpoint. *W. E. Hartshorn.* Med. Record, Jan. 7, 1922, 101, No. 1, 17-18.—The question of compulsory health insurance will probably be one of the important issues considered by several state legislative bodies at their next meeting. The standard bill adopted by the American Association for Labor Legislation provides that all employees earning less than a given amount (ranging from $800 to $1200) shall be entitled to medical, surgical,

hospital, and nursing care, dental treatment, maternity benefits, cash benefits, and funeral expenses. The state is to provide one-fifth of the fund, two-fifths is contributed by the employer, and the remaining two-fifths by the employee in the form of compulsory payments of a certain percentage of his wages, variously estimated from 3 to 7½ per cent. Employees receiving less than $5 per week pay nothing, the employer paying in these cases 80 per cent, and the state 20 per cent.

The brief of the model bill claims: (1) that there is at present a disproportionately large amount of sickness among employed persons causing immediate loss of time and wages amounting to half a billion dollars annually; (2) that the wages paid to American working men are inadequate to enable them to meet the expenses of sickness, etc., and that it is necessary to distribute this burden.

Objections are offered on the ground that statistics in this case are very imperfectly prepared, that as presented the plan is simply a method of taxing the citizens of the state, directly or indirectly, to furnish medical and surgical service to maintain the productive efficiency of part of the population, and that it is essentially a socialistic idea, and not really insurance at all. The American Medical Association and the Federation of Labor have both gone on record as opposed to it.

It has been suggested that each state, where bills are presented, request the legislature to appropriate a sufficient amount of money to enable the state board of health to make a complete and exhaustive survey of the entire state, showing how the existing health organizations may be increased and developed to a point where every citizen of the state, regardless of economic condition or industrial status, may be protected from disease and may enjoy the highest degree of efficiency. Each physician should co-operate in every way with the committee of the state medical society, informing the public and the profession, through a campaign of education, regarding the exact status of compulsory state insurance.—G. E. Partridge.

REHABILITATION OF DISABLED EMPLOYEES

Federal Aid in Industrial Rehabilitation. *Tracy Copp.* Nation's Health, Feb. 15, 1922, 4, No. 2, 59-60. The federal government is offering to finance jointly with the states a plan to place persons handicapped by disease and accidents, whether incurred while working in an industrial establishment or otherwise, in positions which will afford the maximum happiness and profit to the individuals. It is hoped that through this scheme not only the individuals concerned will benefit, but that society and industry as well will reap a real profit.—L. A. Shaw.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

VOLUME IV DECEMBER, 1922 NUMBER 8

CONTENTS

GENERAL

CONDITIONS IN THE GLASS INDUSTRY. *J. E. Harston.* Ann. Rep. Chief Inspect. Factories and Workshops for 1921. Cmd. 1705, 1922, pp. 108-113.—Glass making, although one of the oldest of British industries, does not today employ more than 50,000 workers. Nevertheless the branches of the industry are almost as varied as the premises and conditions of work; old and dilapidated works and small employers contrast with modern factories with up-to-date machinery and labor-saving appliances. The introduction of red lead, often in a dry state, as a component of the "metal" constitutes a risk which in badly lighted and ill-ventilated rooms leads to plumbism; but the risk is minimized when the mixing is done by power-driven, dust-tight machinery without any handling, or when the red lead is moistened before use.

In recent years the glass house has been the scene of improvements; compressed air is replacing human lungs for blowing; automatic machines are superseding hand labor; and douches of cool air are tempering the discomfort from intense heat. Cataract from exposure to heat rays continues to occur, although compensation claims therefor are not numerous. Taken as a whole, glass making, when carried on under good conditions, cannot be considered dangerous or unhealthy. There is a tendency, especially marked in the bottle trade, for larger works to supplant smaller ones; this tendency is to be welcomed, as it is associated with substantial betterment in general factory conditions.—E. L. Collis.

SOME PRACTICAL EXPERIENCE SLANTS ON THE FIVE-DAY WEEK. Abstracted from Mfg.

Clothier, New York, in Factory, July, 1922, 29, No. 1, 30.—The Joseph and Feiss Company, manufacturers of men's clothing, are the real pioneers of the five-day-week plan. In spite of criticism of the plan, on the ground of its impracticability, it has had great success in plants where the cost of making ready for a day's work cuts heavily into the profits of a four-hour day on Saturday. The four decided advantages to be gained by the five day week are:

First, the saving in power. It is found that the same results are obtained by running the machines on 10 per cent. less time.

Second, the reduction in absence and labor turnover. It is noticed that the employees work more consistently during five days with the prospect of a full week-day to themselves.

Third, new sources of labor supply. The five-day week affords the opportunity for employment to many women who would otherwise be unable to work in a factory without having at least two days a week to devote to their domestic duties.

Fourth, more balanced production. With a definite amount of work to finish, the planning may be more exact when the forty-four hours, which the employee is required to work at this plant, are divided into five days instead of five and a half.—M. C. Hamblet.

SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

CIRCULATORY SYSTEM

Heart Disease in Industry—Border Line Cases. *Cadis Phipps.* Nation's Health, July 15, 1922, 4, No. 7, 434-435.—"It is not the obviously damaged heart which is neglected: it is the obscure, or borderline, case. A borderline case is oftentimes more amenable to treatment than the established or long-continued lesion, and so may be benefited if recognized. To determine if an obscure heart lesion be present, it is usually not sufficient to depend upon a routine physical examination; a careful history of the symptoms and a consideration of various etiological factors, combined with several physical tests, must be employed.

"Besides protecting the industry, the employee's health must be of prime interest. His interests are best served (in regard to cardiac disease) by (1) removal or preventive treatment of possible causes; (2) earliest possible recognition of cardiac disease; (3) complete rest for a sufficient period of time, followed by (4) a gradual return to working conditions, never reaching the limit of the heart's ability."—M. C. Shorley.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Hazards of Carbon Monoxide from Gas Burners. *I. V. Brumbaugh* and *G. W. Jones.* Abstracted from Gas Age-Record, 1922, 49, 427-429, by J. L. Wiley in Chem. Abstr., June 10, 1922, 16, No. 11, 1852-1853.—"Tests of the combustion products from burners using natural gas and burning in contact with utensils containing liquids at or below the boiling point of water show that CO is liberated in amounts depending upon: distance of the utensil above the burner; height of blue inner cone of flame; type of burner; flame characteristic (ratio of volume of primary air injected into burner relative to volume of gas consumed); rate of consumption of gas. No CO was found where the distance of the utensil from the burner did not allow the blue inner cone to touch the utensil. A yellow flame will produce CO at a rate greater than a blue flame. The chilling of the flame by the cold utensil produces CO. With a burner using 8 cubic feet of gas per hour and burning with a yellow flame in an unventilated room the CO % of the air increased from 0.02 at the end of 0.5 hour to 0.16 in 3.1 hours, at which time the flame was smothered, owing to the high % of products of combustion and the lack of supporting O."

Mercury Poisoning. *R. R. Sayers.* Abstracted as follows from U. S. Bur. Mines, Rep. Investigations No. 2354, 1922, in Chem. Abstr., July 20, 1922, 16, No. 14, 2367.—"Hg poisoning occurs whenever Hg in finely divided form, as in fumes, oil suspension, or aqueous solution, comes in contact with the skin, lung tissue or the digestive tract. The symptoms include stomatitis, salivation, tremors, with degenerative organic changes. Proper ventilation and personal cleanliness obviate most of the bad effects in those otherwise healthy. Hg appears to combine with the brain tissue and to interfere with motor but not sensory nerves. The mucous membranes become inflamed and ulcerated. Anemia is almost always present, very marked if exposure covers a long period. Remedial measures are principally forced ventilation and personal cleanliness. Attention to hygiene, including bathing, protection by clothing and masks, clean clothes, regular habits of elimination aided by Mg citrate are essential for health when exposure to Hg is continuous. Suggested rules are given in detail by which workers may avoid most if not all of the ill effects of Hg absorption."—Philip Drinker.

Lead Poisoning in the Pottery Industry. Lancet, July 15, 1922, 203, No. 5159, 141-142. —Some increase in lead poisoning is recorded in the pottery industry during 1921, even though a particularly stringent code of regulations for its prevention applies to this industry. The increase in case incidence, however, is slight, and remains far lower than before the regulations were established—twenty-four cases in 1920, and thirty-four in 1921, in comparison with an annual average of seventy-six for the years 1909 to 1911. On the other hand fatal cases remain unreduced in number; but examination of length of employment of the victims disclosed the fact that the poisoning was incurred many years previously; thus, of eleven workmen who died from lead poisoning in 1921 nine had been employed on an average of thirty-four years. For a chronic poison like lead, many years must elapse before the benefit of lessened risk can find expression in mortality data.—E. L. Collis.

Health and the Five-Day Week for Painters. *Louis I. Harris.* Am. Labor Legis. Rev., June, 1922, 12, No. 2, 126-127.—The writer studied 400 painters and learned that about 60 per cent. were suffering from lead poisoning, and about 40 per cent. had marked symptoms in an active form. About 9 per cent. showed that the poison was latent within various structures of the body. About 11 per cent. were borderline cases in which the evidence of the presence of lead in the various organs was strongly suggestive of beginning lead poisoning. The painter's trade has been shown time and again to be an extra-hazardous one. Physical strain adds to the danger, and various volatile poisons used are an additional menace. A relatively small proportion of painters can retain their place in the industry after the age of 50. The reduction of weekly hours of labor is a necessary health measure.—G. E. Partridge.

Labour Members' Bill Concerning the Use of White Lead in Painting. Abstracted as follows from New Zealand Herald, Feb. 1, 1922, in Internat. Labour Office, Indust. and Labour Information, April 21, 1922, 2, No. 3, 34.—At a recent session of the New Zealand Parliament, a member contended that an excellent non-poisonous substitute for white lead in paint had been found, and that steps should be taken to prohibit the use of white lead, as it was an immense danger, not only to painters, but to the health of the occupants of houses.

Laws and Regulations Relating to Lead Poisoning. *Gilbert Stone.* Abstracted from Publication of Imperial Mineral Resources Bur., London, 1922, pp. 250, in Internat. Labour Rev., June, 1922, 5, No. 6, 1026.—Legislative measures taken in the following industries are described: (1) lead mining; (2) lead smelting; (3) white lead; (4) manufacture of paints and coloring matter; (5) pottery (manufacture and decoration); (6) electric accumulators; (7) use of coloring matter; (8) lead-coating; (9) vitreous enamelling; (10) the twisting of wire dipped in lead; (11) file-cutting; (12) bronzing, lithographic, and printing processes.

In the second part of the book, the legislative texts are given in full. A chapter is devoted to compensation. An appendix gives the British regulation of August 23, 1921, concerning the manufacture of lead compounds (carbonate, sulphate, and acetate of

lead, etc.) and also the Act of November, 1921, relating to the employment of women and young persons in lead industries.—G. E. Partridge.

DUST HAZARDS AND THEIR EFFECTS

Studies in Experimental Silicosis and Other Pneumonokonioses. *A. Mavrogordato.* South African Instit. Med. Res., Johannesburg, 1922.—Three years ago Dr. Mavrogordato, who had worked in England with Dr. Haldane on the effects produced by dust inhalation, proceeded to South Africa to continue his studies on the Rand gold field, where silicosis is recognized to be a serious occupational danger. The present monograph, which has been awaited by all interested in the subject, is based upon experimental exposure of animals to dust inhalation, and upon clinical observations and material available at Johannesburg.

Dr. Mavrogordato first tells his story, setting forth his facts, his arguments, and conclusions; then in a series of appendices he describes in detail the methods followed in his experimental observations; finally he presents a series of 114 excellent microphotographs to illustrate the text. The whole work is of first-rate importance and decidedly advances our knowledge of silicosis. Epidemiological observations by Collis first drew attention to the peculiar danger in relation to dust phthisis associated with silica dust. Experimental work is now fully corroborating the importance of those observations, for the results obtained with silica dust are found to differ from results when other dusts are used. The old mechanical theory of the harmfulness of dusts now receives its quietus. "It is not the particle that penetrates the tissues, it is the tissues that take up the particle. . . . Solubility and chemical inertness or activity are important, but the sharp edges or acicular shape of dust particles are of little more than historical interest."

Dr. Mavrogordato describes his observations using various dusts; but reference to his work with silica particles needs only be given here, for he concludes that ultramicroscopic particles of chemically inert dusts are not dangerous. Silica particles appear to possess a peculiar property in protecting cells which ingest them from autolysis and from digestion in the lymph; and the suggestion is made that such particles are slightly soluble in the alkaline tissue juices, and that alkaline silicate so formed pervades the cell, preserving it like a mummy, as water-glass preserves eggs. Here we recall the work of Gye and Kettle, who insist upon the importance of the chemical factor in the behavior of silica dust and relate it to the formation of silicic acid. These workers have shown that silicic acid is in itself a poison, and that it breaks down tissue resistance to tuberculous infection. Cells containing silica particles flock together to form pseudo-tubercles, but not if they contain other dust particles; the appearances resemble those of a positive and negative Widal agglutination respectively. In this way fused aggregates of silica-laden cells are formed, constituting an anatomical tubercle; the similarity with early stages of tuberculosis is remarkable. Later the pseudo-tubercles undergo fibrosis and obstruct the lymphatics. Evidence is advanced that cells which ingest dust — that is, dust-cells — originate from the epithelium lining the alveoli and the blood vessels; they are macrophage cells of Metschnikoff.

The low incidence of phthisis among coal miners gives interest to inhalation experiments in which dust of coal and silica was used, and to the conclusion that "once silica is fixed in the lung tissues, coal exerts no eliminative effect, if anything the influence is in the opposite direction, but a prior or even simultaneous exposure to coal dust appears to set up a condition in the lung which is inimical to the fixation of silica." Possibly other organic dusts may exert a similar influence, but up to the present time no experiments have been undertaken. Collis has, however, pointed out that fireclay dust appears to preserve ganister-brick makers from tuberculous silicosis.

Mavrogordato lays particular stress on the part played by microbic infections in modifying and accelerating the pathological changes associated with silicosis, and suggests that while tuberculosis is by far the most important infection, other organisms may also

exert an influence. Here he finds explanation of the undoubted harm associated with abrupt variations in high air temperature and humidity which favor respiratory diseases in general. Apart from infection, simple silicosis is a stationary condition when exposure to dust ceases; but after infection it need not remain stationary, since microorganisms multiply on their own account.

The type of disease seen now is more dependent on concurrent infections than was the old type; first, because dust exposure has been lessened and, secondly, owing to the employment of more men of Afrikander stock with less inherited resistance, and of fewer men of salted Western European origin. Hence cases of massive fibrotic silicosis are now rare, but cases in which tuberculous infection is present at an early stage are more common. The suggestion made that great damage is done by the non-tuberculous infective factor is held to justify systematic investigation of the flora, other than the tubercle bacillus, commonly present in the sputum of miners. The whole monograph deserves careful consideration, not merely by those interested in tuberculous silicosis, but by those concerned with other manifestations of tuberculosis.—E. L. Collis.

Silicosis among Stonemasons. Abstracted from The Builder, Feb. 17, 1922, in Indust. and Labour Information, Internat. Labour Office, April 28, 1922, 2, No. 4, 42-43. —A report on silicosis among stonemasons was presented at a quarterly meeting of the Industrial Council for the Building Industry on February 10, in which it was stated that the Safety and Welfare Committee had concluded that the case for the inclusion of stonemasons in the Silicosis Act was an unanswerable one. It was shown that death from silicosis in this trade was in excess of the general rate comparable with it. A table was presented showing that the mortality was greater in sandstone districts in England than in limestone or granite districts.—G. E. Partridge.

Some Conclusions on Commercial and Experimental Methods of Collecting Dust and Fume in the Zinc and Blast Furnace Industries. *F. G. Breyer.* Informal address before the Portland Cement Assn., May 21, 1921. Reprinted in Jour. Am. Soc. of Heating and Ventilating Eng., 1922, 28, 288.—The author distinguishes between dust and fume primarily with regard to the fineness of the product. For his classification he places all dusts made by milling or comminution in one category, and fume products, such as potassium chloride and sodium chloride, iron oxide, and zinc oxide, in the other. The difficulties in handling fume products, such as are encountered in the zinc industry, are discussed, and a theoretical explanation of the physical state and size of the particles is advanced. The effect of "clumping" or flocculation of particles is pointed out and the importance of getting the particles into this state, if they are to be collected, is mentioned.—Philip Drinker.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

The Diagnosis of Pulmonary Tuberculosis from the Standpoint of the Industrial Physician. *Frank A. Craig.* Am. Rev. Tuberc., June, 1922, 6, No. 4, 265-281.—The author summarizes as follows:

"1. We believe that for the early detection of pulmonary tuberculosis there can be no question that the carefully conducted health survey is the most valuable method at our command, especially valuable being the entrance examination, combined with periodic reëxaminations of the entire force.

"2. The diagnostic standards adopted by the National Tuberculosis Association do not appear to be applicable in the routine examination of large industrial groups.

"3. The tuberculosis incidence rates which appear in literature as the findings of medical examiners in their studies of numerous industrial bodies are so lacking in uniformity and are so frequently unaccompanied by qualifying, defining, or explanatory information that they are almost valueless for comparing the findings of one industry with

those of another. It would seem as though some standardized method for reporting such cases was definitely needed, before it would be possible to establish average tuberculosis morbidity rates for various occupations."

In conclusion the author states:

"1. The examination of large bodies of men for the presence of pulmonary tuberculosis presents many, but not insuperable, difficulties, and in each case the diagnosis must rest upon a careful correlation of all the findings. While the most important information is that obtained by a physical examination of the patient, including inspection, palpation, percussion and auscultation, there are other methods of study which possess considerable value in the formation of the diagnosis.

"2. The *history* of the case is of the utmost importance, but is seldom obtainable or reliable in the study of large groups of men.

"3. In the routine examination of large bodies of men the recording of *temperature* seems to be of questionable value, although it may prove invaluable in the study of individual cases.

"4. From the standpoint of tuberculosis the recording of the *pulse rate* offers very little if any information of value.

"5. *Loss of weight* is a finding of considerable value and one which is readily obtained. The age and height must be taken into consideration in studying the weight of the individual.

"6. A systolic *blood pressure* which is below the normal for the age of the patient is a very suggestive finding. The recording of the blood pressure should be included in the study of every large body of men for many reasons."

Occupation and Tuberculosis. *Koelsch.* Abstracted from Zeitschr. f. Tuberk., Oct., 1921, 34, p. 581, in Am. Rev. Tuberc., July, 1922, 6, No. 5, 147.—"We must make a distinction between a case of pulmonary tuberculosis due to childhood infection which is provoked into activity by occupation and a case due to massive reinfection of the worker in the factory. In the former the occupation *per se* causes a flaring up of a process already present from childhood; in the latter the active tuberculosis is caused not so much, if at all, by the occupation, but merely by an accident of circumstances such as careless expectoration by tuberculous workmen in the shop. Besides these direct causes of occupational tuberculosis, there are indirect causes, such as poor wages and consequent poor housing, poor food, scant clothing, etc. Only cases of the first kind should be considered as occupational tuberculosis. The main occupational cause of activation of a quiescent tuberculous process is dust. Only certain types of dust, however, are responsible for the activation of a latent tuberculous process, namely, dust that remains in the lung tissue, such as quartz and silica; whereas coal dust is in great part transported from the lung by the phagocytes and the lymph channels. Of 1,800 persons examined, 100 were stone-masons, 1,000 porcelain workers, 100 ball-bearing grinders, and 600 workers in cement, with a percentage incidence of siderosis of 63, 45, 30 and 15 respectively. Siderosis often activates a latent tuberculous process, but the percentage in the above-mentioned workers was not ascertained."

The Relationship of Tuberculosis and Injury. Tubercle, June, 1922, 3, No. 9.—Dr. N. Tattersall challenges the accepted opinion that tuberculosis may be determined by trauma, pointing out that experimental work on the one hand and war injuries on the other do not support this view. He considers, however, that the evidence is clear that injury may activate pre-existing and possibly latent foci, and that as a result a sudden massive dose of bacilli may be disseminated through the tissues. In pulmonary cases the mediastinal glands are probably the site whence dissemination follows upon injury. When lighted up by injury tuberculosis appears promptly, that is, after a few days or weeks. Hence, in considering any case, knowledge of previous health and of the rapidity of development after the injury, is of great importance.

Dr. A. Brownlee reviews the literature and describes cases in support of Tattersall's view that while trauma may aggravate, it seldom if ever, originates tuberculosis. He points to the rarity of tuberculosis among the numerous group of athletic injuries. Injuries are common and tuberculosis is not unusual, but

the combination is sufficiently unusual as to fall within the limits of coincidence.—E. L. Collis.

The Coal Mine as a Tuberculosis Sanitarium. Am. Labor Legis. Rev., June, 1922, 12, No. 2, 131.—Mortality statistics cannot be accepted as an indication that coal mining is a desirable occupation for tuberculous patients (although it has been stated that coal dust may not be injurious to the lungs). Lack of rest and of sunshine, exposure to changing temperature, poor housing, etc., are not favorable conditions for the tuberculous. The death rate from tuberculosis among miners is perhaps lessened by the high rate of deaths by accident, and by the fact that tuberculous miners seek other occupations in which to die.—G. E. Partridge.

Syphilis as an Economic Factor in Industry. *J. M. Quirk.* Reviewed from Internat. Jour. Surgery, May, 1922, 35, No. 5, in Pub. Health Jour., July, 1922, 13, No. 7, 333.—"The author gives a general discussion of the history and prevalence of syphilis. Syphilis attacks every organ and tissue in the human body and simulates almost every known disease. Its lesions are not always easy to distinguish, and the author states that he often has men reporting all sorts of injuries that are primarily due to syphilitic lesions. In its late manifestations with the involvement of the deeper tissues, we again have a serious economic charge against industry. The diseased bone of the syphilitic snaps in some slight injury and convalescence is prolonged beyond the normal limit. The patient affected with syphilitic aortitis dies from some slight injury—industry pays. A trivial trauma to the head may be followed by an epileptiform attack common to syphilis, and industry pays. A neurosyphilitic loses muscular co-ordination or mental concentration, an accident occurs and industry pays. What shall industry do? Encourage education and treatment. Lecturers should be engaged, for lecturers are preferable to pamphlets, because many will listen to that which they are unwilling to read. The author recommends, besides, prophylaxis and prophylactic education for industry."

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Dermatosis Following the Use of Cutting Oils and Lubricating Compounds. *William J. McConnell.* U. S. Pub. Health Ser., Pub. Health Rep., July 21, 1922, 37, No. 29, 1773-1794.—An excellent critical inquiry of the subject is presented, together with a bibliography. *Part I* discusses the advent, classification, analyses, uses, application, reclamation and sterilization of cutting oils and lubricating compounds. *Part II* deals with cutting-oil dermatosis — its prevalence, lesions, symptoms, prevention, and theories as to its causation.

Several plants were studied. Recommendations for the prevention of dermatosis consisted in the use of a sawdust-liquid soap mixture for thoroughly cleansing, followed by the application of lanolin before beginning work in the morning, and after lunch. After work the hands were to be washed with warm water and soap, and dried. No emollients were to be applied unless actual abrasions were present. Lesions on the thighs are best prevented by wearing aprons impermeable to oils. In plants where the preceding precautions were strictly enforced, the dermatoses were eliminated within eight months; in plants where the preventive measures were available but not enforced 21 per cent. of the former patients still had dermatosis, and when the measures were not supplied, though recommended, 48 per cent. still had dermatosis.

The oils and compounds produce initial dermatosis by obstruction of the sebaceous follicles—the underlying cause being a deficiency of the natural oiliness of the skin. Infections are secondary.

Prevention depends upon thorough cleanliness and the application of lanolin and castor oil to the skin before beginning work. Cure is accomplished by rest of the affected part and by constant use of the preventive measures.—B. Cohen.

Skin Irritants: External and Internal. *C. Guy Lane.* Boston Med. and Surg. Jour., July 20, 1922, 187, No. 3, 108-115.—In a re-

view of the records of 600 cases with the diagnosis of dermatitis at the Massachusetts General Hospital Out-Patient Department, 11 per cent. were found to be of industrial or probably industrial origin, housewives being included in this classification. For the dermatitis of printers, the use of a mixture of liquid soap and sawdust for cleaning purposes and of lanolin and oil before going into the pressroom was sufficient to prevent further eruptions. Among rubber vulcanizers using hexamethylenetetramine, the immersion of exposed parts in an alkaline solution, such as a saturated sodium bicarbonate solution, before going to work, prevented eruptions in sensitive individuals. Mention is made of dentists susceptible to novocain.—B. Cohen.

Arsenical Pigmentation of the Skin. *D. W. Montgomery* and *G. D. Culver*. Abstracted as follows from Med. Rec., 1922, 101, 665-667, by F. S. Hammett in Chem. Abstr., June 20, 1922, 16, No. 12, 1988.—"Skin pigmentation by As is an example of the stimulating effect of the element on metabolism."

Agricultural Conjunctivitis. *James F. Patton* and *Sanford R. Gifford*. Am. Jour. Ophth., Aug., 1922, 5, No. 8, 623-637.—The author concludes as follows:

"1. Six cases were seen, all but two of which presented the common features of enormous swelling of the lids, swelling of the regional lymph nodes, superficial necrosis of the skin of the lids, and membrane on the conjunctiva. The other two, though lacking one or two of these signs, were similar enough to warrant their inclusion as atypical cases.

"2. All occurred in healthy adult or adolescent males engaged in outdoor occupations.

"3. Three gave a history of slight trauma to the conjunctiva or lids. None had been exposed to diphtheria or showed any signs of it on other mucous membranes.

"4. Mixed infection was present in all cases, the streptococcus, staphylococcus, *B. xerosis*, and a large grampositive anaerobic bacillus being found. The last was probably present in five of the six cases, and on account of the rarity of similar findings on normal lids or conjunctiva, is considered as possibly having an etiologic relation to the cases.

"5. The cases seemed to form a distinct enough clinical picture to warrant their inclusion in a group for which the name 'agricultural conjunctivitis' is suggested."

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Industrial Accidents. *S. Garcia-Tornel*. Abstracted as follows from Rev. Espanola Med. y Cirugia, Feb., 1922, 5, No. 44, 78, in Jour. Am. Med. Assn., June 3, 1922, 78, No. 22, 1767.—"This is a detailed report of the recent Spanish congress on industrial accidents, the first of its kind. The address of the president, Dr. Oller, was entitled 'Medical reforms necessary to introduce in the bill now pending on industrial accidents.' A resolution was adopted to the effect that when an operation is necessary and harmless, the injured workman should be given the choice of submitting to the operation or relinquishing his claim for indemnity. Another resolution referred to a conflict of opinion between medical experts in cases involving workmen's compensation. In this case the workman should be examined by the local professor of surgery, a hospital surgeon, and a surgeon member of the Academy of Medicine or, if not available, a corresponding trio appointed by the local medical society. One resolution stated that hernia and lumbago should not be considered as permanent disabilities."—C. K. Drinker.

Industrial Accidents in Mexico during 1920. Abstracted from Internat. Labour Office, Indust. and Labour Information, Jan. 13, 1922, p. 50, and Feb. 3, 1922, p. 47, in U. S. Bur. Labor Statis., Month. Labor Rev., June, 1922, 14, No. 6, 155.—"An official report of industrial accidents in Mexico during 1920 shows that the mining industry was responsible for 6,719 of the 7,019 accidents, affecting 7,031 and 7,404 persons, respectively. The transportation industry stood second with 122 persons injured in 114 accidents, and metallurgy third with 127 persons injured in 77 accidents. Of the 7,404 injuries, 6,247 were slight, 798 serious, and 359 fatal. Of the

nonfatal accidents 94.96 per cent. occurred in mining, 1.70 per cent. in metallurgy, and 1.65 per cent. in the transportation industry. A total of 471,732.98 pesos ($235,158.89, par) was paid out in the form of indemnity and aid."

Accident Prevention a Branch of Welfare Work. *D. D. Goldingham.* Indust. Welfare, 1922, 4, No. 8.—This is the first of a series of articles to appear on this subject. It is stated that welfare workers have not paid much attention to accident prevention as yet, first, because of their misconception of the causes of accidents, and secondly, because of the high standard of machine guarding in factories inspected by the factory department. "An understanding as to the real cause of accidents and the psychology of human beings is of greater value in the preventive field than an intimate acquaintance with machinery or machine guarding." Hence the welfare worker has an important part to play. A table containing the results of the investigation of 5,000 industrial accidents is given. Of this number 29.42 per cent. were nonmechanical; of the mechanical accidents (20.58 per cent.) it is doubtful if 10 per cent. could have been prevented by more efficient safety devices.—E. Hewitt.

Accidents at Metallurgical Works in the United States during the Calendar Year 1920. *William W. Adams.* U. S. Bur. Mines, Tech. Paper 297, 1922, pp. 28.—"The tables in this publication have been compiled by the Bureau of Mines from reports furnished voluntarily and directly by operators of ore-dressing plants and smelters throughout the United States, with the exception of information for the States of California and Utah. The statistics herein presented, although not altogether complete, represent the entire metallurgical industry except iron blast-furnace plants, accident reports for those not being received by the Bureau of Mines. The figures for smelting plants cover copper, lead, gold, and silver smelters and refineries; those for ore-dressing plants represent concentrating plants for copper ores, lead ores, zinc ores, stamp mills, cyanide plants, iron-ore washers, flotation mills, and sampling works."—M. C. Hamblet.

Coal Mine Accidents. Am. Labor Legis. Rev., June, 1922, 12, No. 2, 122-124.—The United States Bureau of Mines reported 2,271 fatal coal mine accidents for the country in 1920, and only 13 per cent. less in 1921, although production was 23 per cent. lower. Probably more than 150,000 non-fatal accidents occur annually in the coal mines in the country. The fatality rate in the coal mines in the United States is three times as high as that of Great Britain, and has been so for many years. The rate in 1910 was four times as high as in Belgium and Austria. The causes are insufficiently stringent laws, inadequately trained inspectors, ignorant foremen and fire bosses, indifferent employers, uninstructed and careless miners. We have not yet eradicated one-half of the preventable deaths.—G. E. Partridge.

Progress in Dust-Explosion Prevention. *David J. Price.* Chem. and Metall. Engin., June 28, 1922, 26, No. 26, 1203-1206.—The author gives a summarized account of explosions in industries where fine dusts of a highly oxidizable type are encountered. Among the explosives, the powders enumerated are flour, cereals, feed, starch and corn products, chocolate, cocoa, aluminum, and hard rubber. Efficient methods of collecting and handling the fine dusts are the obvious remedies suggested.—Philip Drinker.

INDUSTRIAL SURGERY

Low Back Pain: Its Cause. *J. T. O'Ferrall.* Abstracted from Jour. Bone and Joint Surgery, April, 1922, 4 No. 2, 384, in Jour. Am. Med. Assn., June 3, 1922, 78, No. 22, 1757.—"Thirty-seven of the forty patients whose histories are reviewed by O'Ferrall designated the lumbosacral joint or the lumbosacral angles as the point of pain, and in each instance tenderness existed at this point or points. Two designated the left hip and thigh and leg as the site of pain, which was probably referred pain due to pressure of the lumbosacral cord from swelling of the lumbosacral ligaments. One patient referred his

pain to the sacrum. Examination revealed that spasm of the spinal muscles existed in some decided form, varying from slight restriction of the spinal motions to complete rigidity, including also so-called 'sciatic scoliosis,' in thirty cases. Inspection of the teeth showed that infective foci existed in the form of necrotic teeth, crowns and fillings (potential infectious foci) in eighteen cases. Five cases showed infected tonsils or nose; seventeen were negative for pathology, and eighteen showed no record had been made of an examination of the nose and throat. The treatment given consisted mainly in clearing up infectious foci, administering mixed treatment for those having a positive Wassermann reaction, or who were otherwise suspected of having syphilis, and in giving occasional doses of acetylsalicylic acid and cincophen. In many cases no other treatment was required than fixation of the spine. O'Ferrall believes that too much dependence is put on the roentgen ray as an aid to diagnosis." —C. K. Drinker.

Study of 208 Cases of Lower Back Pain. *J. R. Kuth.* Abstracted as follows from Jour. Bone and Joint Surgery, April, 1922, 4, No. 2, 357, in Jour. Am. Med. Assn., June 3, 1922, 78, No. 22, 1757.—"Pain in the lower half of the back was the chief complaint in all cases analyzed by Kuth. The most frequent site was the sacro-iliac area, 97 times. Next in frequency were: the lumbar area, 55 times; lumbosacral area, 31 times; gluteal area, 19 times; dorsolumbar area, 11 times; coccygeal area, 4 times; dorsal area, 2 times, and in the midsacral area, once. Aside from pain in lower back, 149 subjects complained of other pains radiating into the lower extremities; in 140, the pain followed down the posterior thigh and often into the outer aspect of leg and foot. These pains were always found on the same side as the back pain or on the side where the back pains were severest. Kuth suggests that in all cases of low back pain the possibility of a progressive disease of the spine or of the spinal cord should be kept in mind. The best results from treatment were obtained in cases in which static abnormalities were corrected, in which lower back structures were protected or put at rest, and in which such structures, if shortened, were stretched. Graduated systematic exercises were an important adjunct in the treatment of many of these cases."—C. K. Drinker.

Traumatic Osteitis of the Wrist. *Mark H. Rogers.* Boston Med. and Surg. Jour., June 1, 1922, 186, No. 22, 730-733.—There is a condition of the wrist that involves one of the carpal bones, either the semilunar or scaphoid, which is often mistaken for tuberculosis, infectious arthritis, or fracture. The onset is very gradual, a matter of months, and follows trauma. There is no trouble for the patient as long as the wrist is rested. Upon return to mechanical work, the disability becomes acute. Three such cases occurring in mechanics are described.—B. Cohen.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Stature in Relation to Physical Standards of Fitness. *C. R. Sylvester-Bradley.* Proc. Roy. Soc. Med., June, 1922, 15, No. 8, War Section, pp. 18-25.—The author concludes as follows:

"(1) That the common practice of using age as the basis for tabulating anthropometrical statistics is fundamentally wrong.

"(2) That standards of physique may be very closely correlated to the trunk length or stature in the normal individual up to the age of 21 years.

"(3) That our physical standards of fitness for the enlistment of recruits into the various services require considerable revision.

"In conclusion, I would remind you that our standards of physique have been arrived at empirically, that is to say, on the false assumption that men of equal physique should be capable of performing an equal amount of work in a given time; but physique is of no value to a soldier or sailor unless he possesses the vigour and mental capacity to carry out all the duties he may be asked to perform in actual warfare.

"To obtain soldiers, sailors or airmen best fitted for the warfare of the future, the recruiting medical officer must be something

more than the hidebound automaton he has been in the past. He must be intimately acquainted with all the characteristics of normal man. To quote from Professor Karl Pearson in his Presidential Address to Section H of the British Association for the Advancement of Science, 1920: 'Psychophysical and psycho-physiological characters are of far greater weight in the struggle of nations today than the superficial measurements of man's body. Physique, in the fullest sense, counts for something still, but it is physique as measured by health, not by stature or eye-colour. But character, strength of will, mental quickness count more, and if anthropometry is to be useful to the State it must turn from these rusty old weapons, these measurements of stature and records of eye-colour, to more certain appreciation of bodily health and mental aptitude, to what we term vigorimetry and to psychometry.' "—M. C. Shorley.

Alcohol and Industrial Efficiency. *Edgar L. Collis* and *Thomas Oliver*. Brit. Med. Jour., Aug. 12, 1922, 2, No. 3215, 244-248, 251-252.—A discussion of this subject which took place at the annual meeting of the British Medical Association, in July, was opened by Professor Collis.

Taking industrial efficiency to mean the carrying on of productive labor with a minimum expenditure of energy, whether such be physical or mental, or be represented by an equivalent in wages or by the money expended on raw material or necessary plant, Dr. Collis defined the subject for discussion to be whether the consumption of alcohol exerts any influence upon these factors, and if so, in what direction. He distinguished between convivial and industrial drinking, but stated his case under the latter heading, at the same time widening its scope to cover working while the system contains alcohol, irrespective of whether the alcohol is introduced during or before working hours.

Bodily activities he divided into reflex and volitional. Study of the reflexes displayed alcohol as a drug which depresses, and while there was a want of direct evidence that the slowing of the reflexes interfered with industrial efficiency, indirect evidence was found in accident occurrence. He mentioned the relationship of an increased accident incidence to pay-day when drinking facilities are unrestricted, and the disappearance of the marked features of this relationship with restricted measures and particularly with prohibition. He quoted Dr. Vernon's experiences with munition workers, before and during the period of restriction on the sale of alcohol, and also gave various American figures showing the effect of prohibition.

Dr. Collis stated that no definite evidence had been acquired, under industrial conditions, of the effect of alcohol upon the efficiency of volitional acts, but that laboratory research had provided certain definite information. He quoted the work of Rivers, Mellanby, Vernon, and of McDougall and Smith, to show that alcohol is not a source of energy for muscular contraction, that it interferes with neuromuscular co-ordination, and that it has a narcotic influence on power of judgment and discrimination. Evidence from industrial experience in this country appeared to be confined to the apparent influence of alcoholic indulgence during the week-end in bringing about lost time on Mondays—evidence which was supported by American experience before prohibition. He again quoted American experience to show increases of output following upon prohibition. A great cause of lost efficiency is labor turnover, but there appeared to be no reliable evidence of the effect of alcohol consumption upon this. He considers that industrial efficiency is interfered with by the habit of spending upon drink money which should be used for purchasing food. The lower the social scale, the greater the proportion of income spent on alcohol—a fact which means that normal laborers who particularly require energy-producing food are not likely to get the proper quantity. He summed up the position as follows:

1. Alcohol is a drug possessing energy which the body can use, but probably not for muscular work.

2. Alcohol interferes adversely with reflex acts and neuromuscular co-ordination. The higher the concentration in which it is consumed the more pronounced is the effect.

3. Alcoholic habits vary with the industry, and where they are most pronounced timekeeping is most irregular.

4. Industrial accidents are increased by

the consumption of alcohol even though in moderate amounts.

5. There is no evidence, either experimental or practical, that alcohol is advantageous to industrial efficiency, but there is much evidence that it is harmful.

6. Prohibition in America appears to be associated with greatly improved industrial efficiency, whether measured by accident frequency, lost time, or output.

Sir Thomas Oliver, in an extremely useful contribution to the discussion, expressed a very definite belief that during the past fifty years all classes of society in the country have been marching toward sobriety. Employment generally, certain trade processes particularly, and also the amount of wages paid—all have an important bearing upon industrial drinking habits; it was his opinion that the establishment of works canteens had done much toward solving the problem. He thought that each industry should attempt to solve the question for itself. He quoted figures which showed that in a coal mine in South Wales the teetotal miners sent to bank 100 tons of coal for every seventy-two sent up by miners who indulged too freely in alcohol; also that in an electrical engineering works in the south of England, where all the employees were abstainers, absenteeism averaged only 0.5 per cent. and the accident claims but 8 per cent. of the premiums paid; whereas in workshops accident claims generally formed 66 per cent. of the premiums paid.

Sir George B. Hunter, of the shipbuilding firm of Swan, Hunter and Richardson, had given Dr. Oliver a statement of the comparative number of hours worked by riveters who were abstainers and riveters who were known to be unsteady. The investigation extended over three weeks and included overtime. The average number of hours worked per week by six total abstainers was 67, 62, 61, 70, 70, and 55, and by four men who were known to be unsteady, 45, 51, 43, and 29. The number of hours worked overtime by the first six was 14, 11, 6, 16, 17, and 6; and by the latter four 16, 10, 3, and 3. No man could do his best, or even any reliable work, after the free use of alcohol. W. F. Dearden.

How Correct Seating Affects Manufacturing Profits. *Irving Salomon.* Indust. Management, June, 1922, 63, No. 6, 326-336.

The importance of the problem of seating lies in its relation to fatigue; and fatigue in turn is closely related to production. Many firms do not yet realize that the problem of factory seating is an individual problem, and that, to be correct, a chair or stool must be adapted to an individual.

There are four elements in the construction of seating: height, seat, back rest, and foot rest, the specifications of which are dependent upon the machine or bench and the nature of the operation.

The first consideration in seating is the construction of a bench. Its height should depend upon the stature of the worker and his relation to the bench or working surface. The most satisfactory seats (as specified in Special Bulletin No. 104 of the Department of Labor of New York) are slightly saddle-shaped and about 16 inches wide. For most work, a seat $12\frac{1}{2}$ to $13\frac{1}{2}$ inches in depth, with the front $\frac{1}{2}$ inch to 1 inch higher than the back, is suitable. In some operations performed at high benches, the round wooden seats have been found to be fairly satisfactory, but these should not be less than $14\frac{1}{2}$ inches in diameter. For some types of work a revolving seat is good.

Practically every investigation has led to the recommendation of backs or back rests on stools as well as on chairs.

Workers should never be obliged to let their legs dangle or to wind them around the legs of the stools. The foot rest (when the chair is somewhat over 18 inches high, the average operator cannot put his feet well on the floor) should be 10 inches or more from front to back and wide enough to hold both feet. A rail or a ledge is not sufficient.

The "sitting-standing principle" has received but little attention from manufacturers as a whole until recently. This means the arrangement of working equipment, particularly the seats, so that a given operation may be done equally well, sitting or standing. Practically everything that has been written on industrial seating approves of this variation principle, and it is probably one of the most direct means of promoting increased production.

The article contains fifteen figures showing types of seating, and equipment, correct and incorrect.—G. E. Partridge.

WOMEN AND CHILDREN IN INDUSTRY

Women in Georgia Industries. U. S. Dept. Labor, Women's Bur., Bull. No. 22, 1922, pp. 89.—The surveys reported were made in the periods from May 28 to July 13, 1920, and from February 15 to April 15, 1921. The first was made in Atlanta, the second extended over the remainder of the state of Georgia; in the sixteen cities and towns included, there were in all 131 establishments employing 9,900 women and girls.

It was found that 64.3 per cent. of the women were employed ten hours or more daily, and only 12.7 per cent. worked less than nine hours. Thirty per cent. of the women had a lunch period of thirty minutes, and the same number were found to have one hour. Median weekly earnings of white women were $12.20, of negro women $6.20.

Workroom conditions reported for 122 plants were as follows: overcrowded and untidy workrooms in 39 plants; cleaning arrangements unsatisfactory in 54; natural lighting inadequate in 22; and artificial lighting inadequate or badly placed in 74; seats either insufficient in number, or makeshift, in 58 places; hazards such as unenclosed overhead belts, unguarded wheels, and set screws, unguarded elevator shafts, in 53 plants; fire hazards in more than one-half the establishments; common drinking cups or none in 81; washing facilities unsatisfactory in 98 plants, and lacking in 9; toilets insufficient in number in 59, and, in 10, men and women using the same toilets. In 101 establishments there were no lunch rooms; in 95, no rest rooms; in 78, no cloakrooms; in 49, no first-aid equipment.—G. E. Partridge.

Child Labor and the Work of Mothers in Oyster and Shrimp Canning Communities on the Gulf Coast. *Viola I. Paradise*. U. S. Dept. Labor, Children's Bur., Pub. No. 98, 1922, pp. 114.—The Children's Bureau of the United States Department of Labor made an investigation of the conditions under which mothers and children work in nine communities in Mississippi, Louisiana and Florida. In all, 423 families with 1,350 children under 16 years of age were included in the study. The work that was investigated consisted largely of shucking oysters and peeling or picking shrimps. Of the children from 10 to 15 years, 25 per cent. were illiterate; and of 649 children from 7 to 13 years of age, 41 per cent. did not attend school.

Most of the cannery work is wet and dirty and is done in cold, damp drafty sheds, the workers standing among the empty oyster shells or shrimp hulls. There are also certain hazards; cuts are frequent and an acid in the head of the shrimp so affects the hands that many persons can work only a few days at a time, and are then obliged to rest to allow the hands to heal.

Earnings are low, and workers who are imported during the seasons are housed in so-called camps which usually are long, low frame buildings, poorly constructed, offering a minimum of privacy, sanitation, and protection against the weather. Serious difficulties are met by families having young children whose mothers work. The work is irregular and the canneries are situated in isolated places making any enforcement of a child-labor law difficult. Hours of work are long and the rates of pay are arbitrary.

The conditions in this industry are described in detail in the report, which includes tabulated data concerning the employment of children, housing, etc., and several illustrations showing processes and conditions. There is an appendix containing the child-labor and compulsory education legislation in effect in Florida, Louisiana, and Mississippi, on January 1, 1919.

No investigation has been made to determine whether the federal child-labor tax law, imposing a 10 per cent. tax on canneries, mills, factories and workshops that employ children under 14 years of age, or children between 14 and 16 years for more than eight hours a day or before 6 A. M. or after 7 P. M. has had the effect of eliminating the younger workers in the industry studied. No steps have been taken by this legislation toward providing necessary schools and lengthening the short terms that prevail in some places. Special provision is needed to solve the problem of the children of migratory families, since neither the community whence they come nor the one in which they live temporarily feels responsible for their education and welfare.—G. E. Partridge.

Accident Hazard of Working Children. U. S. Bur. Labor Statis., Month. Labor Rev., June, 1922, 14, No. 6, 149-150.—The Statistical Bulletin of the Metropolitan Life Insurance Company, of March, 1922, showed that among the policy holders of the company there were 199 fatal accidents among working boys between the ages of 13 and 17, in 1921, 43 of which resulted directly from the work in which the boys were engaged. A recent study in a textile mill in Connecticut showed that of 1,164 accidents in which the ages of the workers were known, more than one-fourth occurred among employees under 20 years of age, although this group included only 15 per cent. of the number employed. In Massachusetts, there were 1,691 industrial accidents to children under 16 years of age in 1919 to 1920, 10 of which were fatal, and a larger proportion resulted in total disability than in the case of older workers. During the past four years there were 4,663 industrial accidents to children under 16 years of age in Pennsylvania, 10 of which were fatal. During these years there were in all 59 fatal accidents to children of 16 and 17 years, although the law prohibits the employment of minors under 18 years of age in extrahazardous occupations.

There is a necessity for proper vocational guidance and better supervision of children at work, but notwithstanding many safety devices and safety campaigns the high percentage of injuries among boys and girls remains. It is suggested, therefore, that young people lack the qualities of attention, concentration, and carefulness that insure safety in industry; the natural carelessness of children, their adventurousness, lack of muscular control, irresponsibility, and love of play are important factors in the high accident rate prevailing among them. There is a need, for these reasons, for strengthening these laws by specifying and increasing the list of occupations that are regarded as hazardous, and by raising the age at which children may be allowed to enter industry.—G. E. Partridge.

Health Examination of Working Children. Boston Med. and Surg. Jour., June 1, 1922, 186, No. 22, 744-745.—The Department of Labor and Industries of Massachusetts is publishing a form for use in the examination of children applying for employment certificates. The form is less detailed than the one recommended by the Children's Bureau. A copy of this form is printed.—B. Cohen.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

The Work of the American Bakers Association in the Development of a Sanitary Code for the Baking Industry. *Harry E. Barnard.* Am. Jour. Pub. Health, June, 1922, 12, No. 6, 494.—Within the last few years the food industries have come to apppreciate the value and importance of sanitation. At the last convention of the American Bakers Association a new constitution was unanimously adopted. The purposes of the association were set out in part as follows:

"Section 1. The development of the baking industry by increasing the use of commercially baked products.

"*(a)* By securing wider application by bakers of improved methods and advanced baking practice.

"*(b)* By education within the industry, to raise the standard of sanitation and trade practices, and to promote the use of wholesome ingredients and the production of products possessing the greatest possible food values.

"*(c)* By encouraging proper, and discouraging improper legislation, and obtaining representation for the industry in all matters before federal and state bodies and consumers.

"*(d)* By promoting intelligent understanding on the part of the public in relation to the operating methods and practices of the trade.

"One of the purposes of the Association is the certification of member bakeries, and the requirements prior to certification are explicit. They read as follows:

Location and Construction of Plant

"1. Every bakery shall conform to the requirements of the sanitary codes or other

statutory provisions and regulations of the state, county, and city in which it is situated, with respect to its location and construction, bakery equipment, operating methods, and health of employees.

"2. Every bakery shall, in any event, conform to the following specific requirements which the Association deems essential:

"(*a*) The bakery shall be so located that drainage to sewers is adequate and that the basement and floors are not subject to recurring or foreseeable flooding.

"(*b*) It shall not be located adjacent to conditions or industries which are inimical to the production of wholesome bread.

"(*c*) It shall have convenient toilet rooms, separate and apart from the room or rooms where materials and doughs are kept and prepared, or where baked products are stored or handled.

"(*d*) Adequate and convenient wash rooms and toilet rooms shall be provided with soap, running water, and clean towels, maintained in a sanitary condition.

"(*e*) Rooms shall also be provided for changing and hanging wearing apparel, separate and apart from the production, storage, and sales rooms.

"(*f*) The bakery shall be properly protected from flies.

"(*g*) The bakery shall have suitable equipment for handling raw materials, doughs and finished products in a cleanly and sanitary manner.

"(*h*) There shall be sufficient ventilation and light provided to insure the health of the employees and the wholesomeness of the bakery products, free from excessive heat, fumes, dust and other conditions inimical to such health or wholesomeness.

Operating Methods

"(*i*) The floors, walls, and ceilings of every bakery, the equipment used in the preparation or handling of bakery products, or their ingredients, and the vehicles, boxes, baskets and other receptacles in which bakery products are stored, handled or transported, shall be kept in a clean and sanitary condition, free from all contaminating matter.

"(*j*) All bakery products and their ingredients shall be stored, handled, transported and kept in such a manner as to protect them from spoilage, contamination and unwholesomeness.

"(*k*) All workmen and employees, while engaged in the manufacture of bakery products, shall be clothed with external garments of washable material which shall be used for that purpose only, and these garments shall be kept clean.

"(*l*) The smoking, snuffing and chewing of tobacco shall be prohibited in the rooms of the bakery where the materials and doughs are kept and prepared, or where the baked products are stored or handled.

"(*m*) No animals or fowls shall be kept in or permitted to enter the bakery rooms where the materials and doughs are kept and prepared or where the baked products are stored or handled.

Health of Employees

"(*n*) No person affected with any contagious, infectious, or other disease, or physical ailment, which may render such employment detrimental to the public health, shall work in a bakery or handle any of the products therein or delivered therefrom. Freedom of bakery employees from any such diseases shall be evidenced by a certificate of medical examination, such examination to be made at least annually.

"(*o*) No person who has had typhoid fever shall be employed in any bakery until adequate clinical examination has proven the applicant free from typhoid bacilli.

"The Code of Ethics reads in part as follows:

"1. I recognize my duty to the American home to be to make my product of highest food value at lowest cost.

"2. I believe that the rendering of honest and efficient service on the part of my employees deserves fair consideration and that they should receive a fair return for their labor and be enabled to enjoy healthful surroundings, both physically and morally. I recognize a man's inherent right to work with freedom of conviction, without prejudice, and I will expect only an honest day's work and thoughtful consideration of our mutual interests and obligations.

* * * * *

"5. I will use no materials or ingredients other than those of known purity and wholesomeness in the manufacture of my products.

"6. I will at all times adhere rigidly to the truth in all my advertising.

"7. I will keep my plant and premises at all times as clean and sanitary as is humanly possible, and welcome public inspection at all times. I shall expect of my employees what the public has a right to expect of me, that we keep ourselves morally and physically clean.

"At least half of the entire bread production of the country, outside of the supply baked in the home, comes from the sanitary plants of Association members."—H. F. Smyth.

Economic Value of Maintaining Clean Windows and Lighting Fixtures. New York State Dept. Labor, Bull. No. 112, June, 1922, pp. 15.—The industrial loss from obstruction of illumination is to be considered as a practical problem; the cleaning of windows, of light bulbs, reflectors, globes and diffusers of artificial illuminating systems is considered as necessary as the sweeping of floors and the oiling of machinery. In cities where much soft coal is consumed, or where numerous chimneys exist, from which volumes of flue dust are ejected, and in places where dust or fibers are released in the processes of work, heavy deposits may be made on window panes, greatly reducing their transparency. The cleaning of windows with water, rags, chamois skins, brushes, and rubber scrapers is widely practiced. The materials generally used are soap and water, but they must be used properly. "There is a field for the person who can improve present day methods of cleaning lighting glassware, in respect to the kind of cloth or device to use, the cleaning compound and the possibility of saving labor."

The methods of cleaning used by three firms, showing ways of economical cleaning and of reducing hazards, are given, and there is a brief discussion of the effect of walls, ceilings, machinery, etc., on light. There are seven photographic illustrations and a photometric chart.—G. E. Partridge.

Efficiency of Various Kinds of Ventilating Ducts. *C.-E. A. Winslow* and *Leonard Greenburg*. U. S. Pub. Health Ser., Pub. Health Rep., July 28, 1922, 37, No. 30, 1829-1839.—This is a study of the uniformity of air distribution attained with ventilating ducts of various designs. The British Departmental Committee on Ventilation of Factories and Workshops (1907) is convinced that the most important factor is the use of slanting branch ducts to the main ventilating duct for securing greatest evenness of exhaust or discharge of air. In the present investigation, it was found that without exception branch ducts gave better results than lateral ports. With either branch ducts or lateral ports, an untapered main duct gave better results than a tapered one. When other conditions were equal, plenum ventilation was more even than exhaust ventilation.

In order to secure the most even distribution, ventilating systems, on either the plenum or exhaust plan, should be constructed with slanting branch ducts, the question as to whether the main duct should be tapered or untapered, being decided by the relative cost of labor and materials involved. Reasonably good distribution can be economically effected with an untapered duct which discharges or exhausts through lateral ports. A tapered duct discharging through lateral ports is likely to give rise to serious irregularity in distribution.—B. Cohen.

INDUSTRIAL INVESTIGATIONS AND SURVEYS

Two Investigations in Potters' Shops. *H. M. Vernon*, assisted by *T. Bedford*. Indust. Fatigue Research Board, Report No. 18, His Majesty's Stationery Office, London, 1922, pp. 74.—(*Review by author.*) Part 1 of this Report, by H. M. Vernon and T. Bedford, is referred to in the article section of this Journal, *4*, page 318. In Part 2, Dr. Vernon discusses the efficiency of various types of potters' drying stoves, with a view to determining whether the overheating of the shops, a condition produced by most of the types of stove in use, is unavoidable. In most of the stoves, there is a rapid current of

relatively cool air passing inwards from the shop through the lower part of the doorway or entrance, and a current of relatively hot air passing outwards into the shop through the upper part of the doorway. At some intermediate position, the "neutral point," air goes neither in nor out, but ascends vertically, owing to the heat rising from the bed of steam pipes on the floor of the stove. The velocity of these air currents was measured by means of the kata-thermometer, and their direction was tested by smoke paper.

It is generally assumed that the back draft air is laden with moisture, derived from the drying ware in the stoves. Numerous hygrometer observations showed that though the absolute amount of moisture in the outflowing air was greater than that in the inflowing air, the relative humidity of the air, or the degree of saturation with moisture, was very much less, owing to its high temperature. In fact, the drying power of the outflowing air, which is approximately indicated by the difference between its wet bulb and its dry bulb temperature, is usually about three times greater than that of the inflowing air. Again, it is generally assumed that the air in potters' shops is very moist, because of the back draft air from the stoves and the masses of wet clay in the shops, but this is not so. Owing to its high temperature, the degree of saturation of the air in the shops is no greater than the degree of saturation of the outside air at the same temperature. This was proved by many hundreds of hygrometer observations, inside and outside the shops.

Pottery manufacturers have always been uncertain as to whether, in the drying of ware of moderate size, it is better to have a rapid current of warm air, or a slow current of considerably hotter air. Both on theoretical grounds and as the result of actual experiment, it is concluded that high temperature is the chief requisite. For instance, let us suppose that one volume of air, on passing from shop to stove, is heated from 60° to 100° F., or alternatively four volumes of air are heated from 60° to 70°. It is calculated that the drying power of the air at 100°, in so far as it depends on temperature, is four times greater than at 70°; in so far as it depends on increased velocity, however, the drying power of the air at 70° would probably be only 25 per cent. greater than at 100°.

Of the various types of "dobbin" stoves examined, none were found to be efficient, in the sense that they not only dried the ware well, but at the same time allowed comparatively little of their heat to pass back into the shops. Some of the "chamber" stoves were quite efficient as long as their doors were kept closed, but many of them had such badly fitting doors, or the doors were so frequently kept open, that they could not be called efficient. The "draw-out" stoves, in which sections containing hundreds of hot moulds and ware were drawn out from the stove as they were wanted, were not efficient, as these sections gave off large amounts of heat to the shop. "Cabinet" stoves, as long as they were kept closed, were very efficient; but best of all were the "mangle-type" stoves, in which the ware was inserted on shelves near the bottom of the stove, and ascended gradually to the top near the vertical steam pipes. Then it descended, and by the time it had returned to the opening below, it had lost nearly all its heat.

Many of the stoves examined had no structural ventilation provided, but it was found that the back draft air from these unventilated stoves was not more saturated with moisture than that flowing from the ventilated stoves. The reason is that the presence of steam pipes on the floor of a stove automatically insures a good circulation of air. In unventilated stoves the whole of this air passes into the shop, but even in well-ventilated stoves usually over half of it passes back. Much can be done to reduce the back draft from chamber stoves by taking more care to keep the doors closed, while the draft from dobbin stoves can be diminished by blocking the gaps at the sides and top of the dobbins. It would be best of all to install cabinet and mangle-type stoves, and have an independent system for warming the shops, instead of depending upon the hot air derived from the stoves, as under present conditions.

An Inquiry into Labor Turnover. Conducted on Behalf of the National Institute of Industrial Psychology. Jour. Nat. Inst. Indust. Psychol., 1922, 1, 103-107.—Of 172 workers engaged at a factory in one year, 121 left. Of these, eighty-eight left of their own accord, four-

teen were dismissed for unsatisfactory work, ten for reduction of the staff, and nine for other reasons. If those dismissed for unsatisfactory work and for reduction of the staff are excluded, the labor turnover works out at 105 per cent. per annum. All the workers engaged were fairly expert, but it was found that their output was about 20 per cent. below the average when they were first employed, and it did not reach a steady value for twenty weeks. It was calculated that the potential average output lost per worker leaving corresponded to eleven days' work. In addition to this direct loss of output there were indirect losses from spoiled work, waste of foremen's time in giving special supervision, extra clerical labor involved, and other causes.—H. M. Vernon.

INDUSTRIAL MORTALITY AND MORBIDITY STATISTICS

Essays on Vital Statistics. *I. S. Falk.* Pub. Health Nurse, June, 1922, 14, No. 6, 299-310.—The registration of deaths is of great legal and commercial importance for several reasons. Adequate statistics for the whole of the United States are not yet available, for the entire country is not included in the registration area and, besides, there are various deficiencies in the reports. Even in communities having up-to-date statistical laws and offices, the deaths are not all registered, and, regarding cause of death, inaccuracy of certification is very great. The accuracy of diagnosis is shown to range all the way from 95 per cent. in diabetes mellitus to 16 per cent. in acute nephritis. Age, place of residence, and occupation are commonly given inaccurately and an intentional misstatement of the cause of death sometimes occurs.

Tables are presented showing death rates for the registration areas of the United States for the years from 1900 to 1920, and for some foreign countries and leading cities. Rates for urban and rural population, for white and colored persons, native born and foreign; age periods; sex; occupation; and dates are given, and some of the sources of misconception in the use of raw statistics are shown.

Statistics in nineteen occupations given by the Metropolitan Life Insurance Company for 1911-1913, for example, show the average age of bookkeepers at death to be 36.5, the lowest in the list, and of farmers and farm laborers, 58.5; but it does not follow that bookkeeping tends to shorten life. Proportionate mortality figures for occupations are apt to be misleading, since a low death rate may only indicate in a particular case that the deaths from other causes are unusually high.

A table showing the death rates from pulmonary tuberculosis in the United States registration area for 1900, although uncorrected concerning the ages of persons employed, shows what the real situation is with regard to the relation between tuberculosis and occupation:

Occupation	Deaths from Pulmonary Tuberculosis per 100,000 Persons 10 Years of Age and Over
Marble and stone cutters	540.5
Cigar-makers, tobacco workers	476.9
Compositors, printers and pressmen	435.9
Servants	430.3
Bookkeepers, clerks and copyists	398.0
Laborers (not agricultural)	370.7
All occupied males	236.7
Steam railroad employees	129.8
Clergymen	123.5
Miners and quarrymen	120.9
Farmers, planters and farm laborers	111.7
Lumbermen and raftsmen	107.1
Bankers, brokers and officials of companies	92.1

—G. E. Partridge.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

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CONTENTS

GENERAL

THE PHYSICIAN IN INDUSTRY: A SYMPOSIUM. Nat. Indust. Conference Board, Special Rep. No. 22, June, 1922, pp. 98.—The National Industrial Conference Board has issued for the Conference Board of Physicians in Industry a report on the work of the physician in industry. This report is in the form of a symposium, contributed to by seventeen members of the Conference Board of Physicians, whose experience entitles them to speak with authority.

In this symposium are discussed many of the problems encountered in medical work in industry. Each author has contributed from his experience, and the collective experience of this group forms a source of information, rich in suggestion and fact, which should do much to identify and clarify the work of the physician in industry and to establish it as an integral and permanent part of the industrial organization.

Each writer has discussed his subject from his own viewpoint, and while the Conference Board of Physicians as a whole endorses these views, all controversial statements are personal opinions of the writers. The value of the work of the physician from the viewpoint of the industrial manager is discussed in the concluding chapter.

Among the questions discussed are physical examinations; training for first-aid; dental work in industry; the definition of the physician in industry and his relation to community problems; tuberculosis and heart disease among industrial workers; the relation of the physician in industry to the various applications of workmen's compensation laws, with special reference to hernia, eye in-

juries, back injuries and occupational diseases; and rehabilitation of the industrially handicapped.

This symposium brings together in concise form the present-day information regarding medical work in industry and makes available, in language readily understood by the layman, and particularly the industrial manager, the principal features of this form of industrial activity.—F. L. Rector.

Factors Determining the Length of Work Day. *Reynold A. Spaeth.* Nation's Health, Aug. 15, 1922, 4, No. 8, 488-490.—The striking fact about the figures respecting the length of day as related to output is the great disparity between the percentage reduction in hours and the change in production. In general it may be said that the chance of reducing hours without reducing output is directly dependent upon the percentage of human energy expenditure in any particular process. In automatic and semiautomatic machine processes the optimum point lies between a nine-hour and ten-hour day. As work becomes heavier with a longer handling time the optimum shifts toward the shorter day of seven or eight hours. Machine employees can be worked ten hours a day profitably to the employer, and, as far as scientific methods have determined, in most cases without physical injury to themselves, but whether this should be done or not is another matter.

The physical aspects of the work-day problem involve, in the last analysis, the discovery of the most efficient relation between work periods with their resulting fatigue and rest. There are, also, mental factors: If an organization is to be effective there must be at work subtle psychical factors involving both incentives to work and the mutual attitude of men and management. There are two groups of stimuli that urge men to work: necessity, and an internal urge, less understood in the craftsman than in the professional worker. It is possible to emphasize the former when the employer class can apply compulsion, but it is necessary also to release and make operative the internal compulsion which is analogous to the internal drive that stimulates the professional man. The variability of human beings must be considered; and considering this, it is probable that some kind of task system is better than fixed hours. If employers will try to develop the enormous source of compulsion from within, the work-day problem will have lost much of its present seriousness.—G. E. Partridge.

What India Is Doing about Factory Working Conditions. Abstracted from The Times (Trade Supplement), London, in Factory, July, 1922, 29, No. 1, 76-78.—A new factory provision in India prohibits very humid atmospheric conditions. An inspector is given authority to compel the repair of buildings or machinery which are in a condition dangerous to human life or safety. There is prohibition pertaining to the employment of women and children in factories. Rest hours are touched upon, at least one day in ten being for rest. Other general provisions are made.—M. C. Hamblet.

SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

A Heretofore Unknown Occupational Disease in the Rope Industry. *Franz Kazda.* Zentrlbl. f. Gewerbehyg., May, 1922, 10, No. 5, 140-142.—A rope maker who had to swing a heavy knife with his right hand developed a large mass on the left thoracic wall. This was composed of connective tissues, developing after he began this work. There was a history of peptic ulcer, followed by symptoms of pyloric stenosis. Operation confirmed the diagnoses, and a gastro-enterostomy gave relief. The trauma of the strain on the thoracic wall from swinging the heavy knife suddenly is thought to have caused undue motion of the stomach about the pylorus as a fixed point, with resulting irritation and predisposition to ulcer formation.—E. L. Sevringhaus.

CENTRAL NERVOUS SYSTEM

Occupational Neuritis of Glass Polishers. *Ludwig Teleky.* Klin. Wchnschr., July 22, 1922, 1, No. 30, 1507-1509.—The author

discusses the various forms of occupational neuritis according to origin, as physical, toxic, or mixed. After referring to the literature he discusses changes and especially paralysis caused by pressure on the ulnar nerve at the epicondyle of the humerus. He reports a series of eight cases in cut-glass workers. The symptoms varied from numbness and weakness of the fingers to paralysis and atrophy of the interosseous muscles in the ulnar region, and in one case the flexor carpi ulnaris was atrophied. He considers that on account of its relative insolubility the lead in the glass can be ignored; and that the causative factor is pressure. The workers lean on their elbows to steady their work and many show callus formation. The left arm is usually held steadier and is more often affected. The prognosis of the paralysis is eventually good, but the early paresthesia should be considered a warning, and protective measures should be taken. He discusses the physical therapy of the condition, and suggests that wider recognition of its occurrence will prevent mistakes in diagnosis. Treatment for syphilis had been erroneously given to one of his patients.—J. W. S. Brady.

CIRCULATORY SYSTEM

Heart Disease in Industry. *W. Irving Clark, Jr.* Boston Med. and Surg. Jour., July 1, 1922, 187, No. 1, 21-23.—A summary is given of observations at the Norton Company, manufacturers of abrasives, grinding wheels and grinding wheel machinery. Attention is directed to Dublin's review indicating that about 2 per cent. of all workers are liable to interruption of steady work, etc., because of heart disease. In industrial work, the most frequent heart lesion found is chronic mitral insufficiency without stenosis; and next in frequency is aortic insufficiency with mitral incompetence.

The average number of employees during 1920 at the Norton Company was 3,200; the number of records reviewed, 8,100; the number of cases of heart disease, 76; the percentage of employees having heart disease, 0.95; the number of persons with heart disease applying for work but rejected, 4.

It is interesting to note that the number of workers with heart disease is about one-half the usual number in industry. This may be due not so much to exclusion because of examination as to the fact that the cardiac worker tends to find his level. That is, the percentage employed in sedentary occupations ought to be higher.—B. Cohen.

The Heart Disease Problem in Industry. *Paul D. White.* Nation's Health, Sept. 15, 1922, 4, No. 9, 553-556.—There is no such complete entity as industrial heart disease. Cardiac symptoms and signs in the industrial worker are the result almost invariably of nervous fatigue or effort syndrome, or of damage by rheumatic fever, syphilis, arteriosclerosis, high blood pressure, or hyperthyroidism, and rarely result from accidents such as wounds to the heart, a blow on the chest, or unusual physical strain.

Accidents may involve the heart in three ways: (*a*) immediate reflex cardiac disturbances from injury to other parts of the body; (*b*) effort syndrome following accidents, particularly severe ones, in nervous people; (*c*) actual injury to the heart resulting from penetrating wounds of the heart and great vessels, from crushing injuries to the chest, blows, or falls causing rupture of ventricular or auricular wall, of the aorta, or of the valve cusps, or, finally, from rupture of the valves, the ventricle, or of an aortic aneurism from sudden violent effort.

Industry has to deal with the true heart disease type of disorder and with the functional disorder type. Thousands of persons with functional disorders have been classified as cardiac cripples and denied work. It is for industry, with proper protection to itself, to find suitable, not too exciting work for these individuals.—K. R. Drinker.

Occurrence and Significance of Systolic Murmurs in Healthy Individuals. *D. C. Parmenter.* Jour. Am. Med. Assn., June 3, 1922, 78, No. 22, 1680-1682.—As a member of the Department of Hygiene of Harvard College the author has been interested in the question of functional heart murmurs.

In 1919 to 1920 it was found that of eighty-four men entering athletic competition about 10 per cent. had functional murmurs in the pulmonic area. The murmur was systolic in time, not transmitted, and usually heard loudest in the recumbent posi-

tion. "All men were subjected to the following test. The heart sounds were auscultated with the subjects in an erect position with the breath exhaled for perhaps twenty seconds. The same was done with the subjects in a recumbent position. The 10 per cent. mentioned above, or eight men who already had such murmurs, showed a definite increase in the volume of sound by reason of this procedure. Twenty-five, or 30 per cent. of the eighty-four men, were found to have no murmurs of any sort under these conditions. The remaining fifty-one men, about 60 per cent. of the men examined, showed a definite murmur, systolic in time, in the pulmonic area. This made fifty-nine men, or 70 per cent. of those examined in this manner, who had a systolic murmur. No apical or precordial murmurs could be produced by this method, the pulmonic area being the only place where any could be heard. In all cases this artificially produced murmur was loudest in the recumbent position."

In 1920 to 1921 similar examinations were carried out for 506 men comprising all candidates for athletic teams in the University. Ten per cent. of these men had murmurs on the first auscultation, and in 56 per cent. a murmur was brought out by the procedure described above. The individuals so detected were kept under observation, but not restricted in activity. The results of this management are indicated in the author's conclusions.

1. The systolic murmur in the pulmonic area, even in an individual with unstable blood pressure and other signs which might disturb a physician, is a physiologic phenomenon which is yet to be explained.

2. Such murmurs need not bar men of the college age from strenuous exercise under some strain.

3. Exercise under these conditions has seemed to improve rather than harm the health of these men, and has served at the same time to demonstrate that they are not quite so efficient physically as those without demonstrable or producible murmurs.

4. The consideration of these murmurs may be a step toward determining in advance a man's functional efficiency in meeting competition, not only in athletics, but perhaps in life in general.—C. K. Drinker.

THE HEART IN TUBERCULOSIS. *G. A. Stephens.* Tubercle, Oct., 1922, 4, No. 1, 7-13.—While discussing the immediate subject of his paper, the author puts forward the suggestion that the "pulse-heart time ratio" gives some indication of the reserve power of the heart. His observations were made on men employed before furnaces, and he holds that the nearer the pulse beat is to the first sound of the heart, the more *useful* is the heart. The point is also made that for a heart to beat more quickly during heavy labor, the pericardial fluid which lubricates its surface should increase in amount. The ideas seem suggestive but they are not clearly or fully expounded.—E. L. Collis.

THE INCOMPETENT HEART AND INDUSTRIAL ACCIDENT. *William H. Holmes.* Nation's Health, March 15, 1922, 4, No. 3, 160-162.—The wide latitude of reaction possessed by the normal heart and the readiness with which it recuperates from fatigue leads to the belief that fatigue alone does not cause failure of a normal heart; the diseased heart may show signs of decompensation following causes which may appear trivial. The discovery of cardiac disease need not debar a man from employment, but should constitute a reason for placing him in a position where this disability will not be increased.

Despite the numerous ways in which trauma may affect a heart, the common causes of cardiac disease must be sought elsewhere. Injury may act as a contributing cause of cardiac failure in the presence of known cardiac failure. A negative history is of no value in determining whether disease existed prior to the trauma. A positive history revealing symptoms of rheumatism, chorea, etc., on the other hand, may be extremely suggestive of preexisting cardiac disease. Certain pathological conditions must be definitely excluded before attributing cardiac disease to an accident.—L. A. Shaw.

MENTAL

FEEBLE-MINDED WOMEN IN NEW YORK INDUSTRIES. *Edith Hilles.* Nation's Health, May 15, 1922, 4, No. 5, 287-289.—The introduction of the feebleminded into industry must be considered from the standpoint of the welfare of the workers, of those with whom they are

associated, and of the public at large. The moron is happiest when provided with agreeable and monotonous work, and experiments that are being made by a knitting mill company show that the employment of feebleminded girls in industry under proper conditions is practical. In this case the girls live in a colony under supervision and are protected in various ways. The writer concludes, however, that it is a grave question whether the state should adopt a permanent policy of placing workers, known to be subnormal, in private industries to compete with a supposedly normal group.—G. E. Partridge.

The Problem of the Mental Misfit in Industry. *George K. Pratt.* Ment. Hyg., July, 1922, 6, No. 3, 526-538.—The work of the neuropsychiatric corps in the late war is reviewed as an introduction to similar work that might well be incorporated in the mental hygiene of industry. In the army examinations men were selected for the first time in the history of the world for qualities other than a sturdy physique and a strong right arm. In other words, the intellectual and emotional factors were considered equally important. The success of this application of psychiatry to choosing soldiers is now well known.

The mental misfit in industry may create as much of a problem as in the army. The important point is to look on workers as individuals, not to lump them as man-power. Modern industry should not look upon its personnel as so many "hands," but as so many hands plus minds, nerves, instincts, and emotions. Individual study can be used in various ways: in the first place, subnormal individuals can be picked out and put at work for which they are well fitted. There are certain jobs at which they do better than people of superior intellect, for example, the monotonous running of automatic machines in large factories.

A more difficult problem is that of the psychoneurotics. These are people with poorly balanced emotional equipments, and vary from men who are merely "touchy," to those agitators and chronic "kickers" who border on being psychotic.

The problem of the development of psychoses among men already employed is discussed, as, for example, general paresis, premature arteriosclerosis, and dementia praecox. It is pointed out that in order to avoid dissatisfaction and friction we must not only weed out these pathological employees but also place the normal workmen properly, so that they will not develop unrest and resentment.—Stanley Cobb.

RESPIRATORY SYSTEM

Pulmonary Aspiration of Particulate Matter, Normally and during Anesthesia. *H. J. Corper.* Jour. Am. Med. Assn., June 17, 1922, 78, No. 24, 1858-1862.—The author summarizes this article as follows:

The immediate intrapulmonary distribution of inhaled particulate matter (smoke or soot) differs from that of the inspiration or aspiration of particulate matter suspended in fluids (India ink). The former is found heaped up at the points of bifurcation of the air passages or on any prominent projections, as seen in the histologic sections, with relatively little being retained in the alveoli; while the inspired fluid quickly reaches the alveoli, where the insoluble particles of it are retained for a comparatively long time by the trap-like action of these terminal air vesicles. While the inhaled particles are fairly uniformly distributed throughout the entire lung, the inspired or aspirated fluid is irregularly distributed, and its location is determined to a great extent by posture. The pulmonary inspiration or aspiration of fluids after nose instillation occurs readily in dogs and rabbits under ether anesthesia, and in the horizontal posture with the head slightly elevated. The inspired fluid is confined to the upper lobes of the lungs and to the side on which the animal lay, while without anesthetic, repeated nose instillations are usually unsuccessful in this posture. In the vertical posture, however, the inspiration of fluids into the lungs is easily attained in rabbits, but less so in dogs, without anesthetic, the fluid being found mainly in the lower lobes. The postural distribution can be imitated in an artificial chest, indicating that it is determined by mechanical means, gravity and inspiration or aspiration. By utilizing the postural data, right or left side upper lobe pulmonary tuberculosis, possessing many of the characteristics of the disease in man as to location, the formation of pleural adhesions, tissue granulation and necrosis, can be

reproduced in dogs, by the nasal instillation of suspensions of tubercle bacilli while the animal is under ether anesthesia and lying on the right or the left side during the operation.—K. R. Drinker.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Blood Transfusion in Illuminating Gas Poisoning. Jour. Am. Med. Assn., June 24, 1922, 78, No. 25, 1977.—Dr. de Harven recently presented to the Société Clinique des Hôpitaux de Bruxelles an interesting case of carbon monoxide poisoning cured by blood transfusion. The patient was in a serious condition and the intoxication was characterized by convulsions occurring every ten minutes, superficial respiration, impalpable pulse, and hazy cornea. There was no resorption after injection of a considerable quantity of saline with epinephrine. Three hundred and fifty cubic centimeters of blood were withdrawn from the radial artery and a transfusion of citrated blood was performed. The effect was excellent. The pulse became palpable; the arterial pressure rose, and the next day it was normal. The following day, the patient was conscious.—K. R. Drinker.

Effects of Intratracheal Medication on Gas Burns of the Respiratory Tract. *Lafayette Page.* Jour. Am. Med. Assn., July 22, 1922, 79, No. 4, 259-261.—This article is summarized by the author as follows:

1. Intratracheal medication is clearly indicated in all forms of inflammation of the lower respiratory tract resulting from the caustic action of poison gases. It should be used as early as possible after gassing, for the purpose of relieving the first symptoms of pain and asphyxia and reducing the extent of secondary infection, by facilitating drainage of the trachea and bronchi and rendering the passages as sterile as possible, through the antiseptic properties of the oil solutions.

2. This method of treatment shortens the process of suppuration in the secondary stage by aiding the lung reflexes, in expelling the necrotic membranes and products of inflammation, and in healing the ulcerated surfaces, thus relieving the strain on the nerve centers and checking the cough and spasmodic efforts to expel the débris; and thus improving oxidation, diminishing toxic absorption and affording rest to the whole organism.

3. Through shortening the healing process, the permanent damage to the pulmonary mechanism is lessened, there is less surface denuded of epithelium, less scar formation, less peribronchial thickening and, consequently, less tendency to chronic bronchitis and predisposition to tuberculous infection.

4. We are convinced from our observations and experience in using this treatment, before, during and since the war, that all forms of laryngitis, bronchitis, bronchiectasis and asthma, with all the different kinds of distressing coughs and spasms associated with these affections, are more quickly and effectually relieved by this form of treatment, and its use is urged in this class of disorders.

The Effect of Gasoline Fumes on Dispensary Attendance and Output in a Group of Workers. *Octavius M. Spencer.* U. S. Pub. Health Ser., Pub. Health Rep., Sept. 22, 1922, 37, No. 38, 2291-2307.—A thorough survey is reported of the working conditions of twenty-two persons operating coupon-cancelling machines. The operators showed a very high dispensary attendance rate in comparison with a control group. This was due to exposure to fumes of gasoline used in cleaning stamps and belts in the cancelling machines. The poisoning from the gasoline fumes was of a mild chronic type. Substitution of kerosene perfumed with anise oil, in the place of gasoline, caused a lower sickness rate and increased production.

Two Cases of Zinc Poisoning. *R. Engelsmann.* Deutsch. med. Wchnschr., April 14, 1922, 48, No. 15, 488-489.—The first case reported was of non-industrial origin.

The second case was of a young man who had operated an oxyacetylene or oxyhydrogen torch in dismantling a ship's boiler. In cutting through the boiler plate he also had

to cut through a heavy sheet (*Zinkoxydplatte*) presumably of zinc (and not zinc oxide). The ventilation of the room was poor so that fumes from the vaporized zinc were inhaled and resulted in symptoms similar to those reported as *Giessfieber*.

Report Presented at the Superior Council of Public Hygiene of France. Rev. d'hyg., March, 1922, 44, No. 3, 255-261.—The conclusions of the report are:

The superior council of public hygiene of France decrees:

1. That, notwithstanding the vote of the International Labor Conference, the French limitations concerning the use of white lead continue to be rigorously enforced;

2. That the provisions of article 79 of the Code of Labor, concerning the prohibition of the use of white lead in the painting of ships, be extended to the painting of vehicles of all sorts.—M. C. Hamblet.

Experimental Plumbism: Therapeutic Efficiency of Some Agents and Comparative Toxicity of Other Metals. *P. J. Hanzlik, Mary McIntyre,* and *Elizabeth Presho.* Proc. Soc. Exper. Biol. and Med., Jan. 18, 1922, 19, No. 4, 192-193.—Experimental chronic lead poisoning was produced by feeding metallic lead bullets to pigeons. Death occurred in an average of twenty-one days. The lethal dose of lead was 0.16 gm. per kilo; the concentration found in the tissues was about 0.075 per cent.; and the current of lead varied between 0.01 to 0.02 gm. per kilo per day. There was a marked loss of body-weight which began at the end of from two to four days and was coincident with a marked loss of appetite.

Beneficial influence was obtained in the advance of the disease by administration of sodium iodide in the food and water, and magnesium sulphate and calcium sulphide in the food.

Lead salts and other metals were not nearly so toxic as lead itself.—J. C. Aub.

A New Case of Manganese Poisoning with Manganese Stuttering in a Worker in Manganese Dioxide. *Heinrich Embden.* Deutsch. med. Wchnschr., April 7, 1922, 48, No. 14, 472.—Since the discovery by Embden (1902) of manganese poisoning in workers in manganese dioxide, health regulations promulgated by the police have caused manganese poisoning to disappear in Hamburg. The new case now reported occurred in a 46-year-old man, who had ground manganese dioxide since 1914. From 1915 to 1919 there was an interval when he was an infantryman in the war. Since then he has been busy at his trade. Until three months ago he was entirely healthy. Recently, instead of the South Russian ore which is no longer accessible, the much harder and more dirty Brazilian ore has been ground.

His illness began about eight weeks ago. The first symptom was stuttering. Then came tremor of the hands, characteristic "action tremor," especially when his hands were reaching up (washing his face). Then walking became more difficult. There is now no vertigo, no headache, no retropulsion or propulsion. He can write only very badly. There is no irresistible laughing. There is weakness of movement, especially mimicking movements. The occurrence of stuttering as an organic symptom (as is the case in chronic mercurial poisoning) brings forward the idea that among genuine stutterers, whom we are accustomed to regard as neurotics, there are perhaps concealed a few organic cases. Whether or not manganese stuttering is a lenticular nucleus symptom, further observation must show.—K. R. Drinker.

Morbid Disturbances Due to the Handling of Celluloid. Jour. Am. Med. Assn., July 8, 1922, 79, No. 2, 146.—Dr. F. Heim, professor of industrial hygiene of the Conservatoire National des Arts et Métiers, with the collaboration of Dr. E. Agasse-Lafont and Dr. A. Feil, examined, from a clinical and hematologic standpoint, women employed in making small portable battery boxes of celluloid. They employed two substances: celluloid powder, containing camphor, and very inflammable; and a sort of glue containing a mixture of equal parts of amyl acetate and acetone. The inquiry revealed one transitory clinical sign, headache, and a persistent and frequent hematologic symptom, eosinophilia. This cause of toxic eosinophilia is important; it resembles somewhat benzene eosinophilia. This eosinophilia is interesting because it gives an almost indubitable proof of intoxication or, at least,

of a reaction to saturation of the organism by fumes of acetone and of amyl acetate. On the other hand, the lack of knowledge of this cause of eosinophilia might entail errors in diagnosis, as when a workman handling celluloid is clinically suspected of intestinal parasites or hydatid cyst, as the diagnosis of these affections is often based on the finding of eosinophilia.—K. R. Drinker.

Quinine Sickness of Occupational Origin. *Blamoutier* and *Joannon.* Rev. d'hyg., June, 1922, 44, No. 6, 521-532.—The author presents the report of a case of quinine poisoning which appeared in a man who worked in a chemical establishment preparing the drug. After two weeks' employment at various processes, including the handling of quinine bark and of powdered bark, and at the process whereby quinine sulphate is produced, edema of the eyelids was noted. Subsequently an itching erythematous eruption involved the face, neck, antecubital spaces, genitalia, and the upper third of the inner aspects of the thighs, associated with some edema and, on the face, with vesiculation.

The blood showed a positive Wassermann reaction, a leukocytosis (18,000), and an eosinophilia (23 per cent.).

Under treatment with moist dressings of eau d'Alibour, with silver nitrate, zinc ointment and ichthyol, and given a mild diet, the patient improved.

The authors discuss the question of immunity and susceptibility to quinine and that of the eruption being of external or internal origin. They are of the opinion that cases of this nature are not essentially different from those originating in the ingestion of quinine therapeutically administered. It was possible in the factory visited to inhale and swallow quinine dust. There are presented certain observations regarding a skin reaction to quinine of possible value in identifying susceptible individuals. A bibliography is appended.—Wade Wright.

DUST HAZARDS AND THEIR EFFECTS

The Feld Scrubber for Cleaning Metallurgical Smoke. *W. F. Lamoreaux.* Engin. and Mining Jour., 1922, 113, 198.—This article contains a detailed account of large scale operations in the recovery of fume from a copper smelter, the primary object being the removal of solids from the fume so that the sulphur dioxide gas remaining can be used as a source of elemental sulphur, and recovered zinc oxide can be used for electrolytic zinc.

From the point of view of industrial hygiene the article is of special interest because of the author's clear, concise exposition of the wetting of the fine fume particles, and the failure of bag filters, coke filters, and Cottrell precipitators to function on a practical scale. Fume recovered by the Cottrell precipitators could not be wetted, except by previous vigorous heating, because of a film of absorbed sulphur dioxide gas.

With the Feld scrubber an efficiency of 95 per cent. was attained in the removal of the fume. The cleaned gases were then passed through incandescent coke, thus reducing the sulphur dioxide to sulphur in the gaseous state. To recover the sulphur from this operation a second Feld scrubber was installed which combined a convenient means of regulating the temperature and a method of collecting the sulphur. To show the difficulty in wetting this sulphur fume the author states that it sometimes was in such a fine state of division that it could be passed through eight thicknesses of closely woven handkerchief linen.

A theoretical discussion of electrical charges on the fume and water particles, the number of contacts between the fume and water, and the effects of valency and electrical charges on the ability of finely divided solids to absorb moisture are discussed.—Philip Drinker.

The Industrial Treatment of Fumes and Dusty Gases. *W. E. Gibbs.* Jour. Soc. Chem. Indust., June 30, 1922, 41, No. 12, 189T-196T.—The subject is treated from the standpoint of colloid chemistry in which smokes, fumes, and dusty gases are regarded

as the disperse systems in which the dispersed substance is solid or liquid, and the dispersion medium air or other gases.

It is shown that settling from air or gases in motion can be effected only in the case of particles larger than 10^{-3} cm. in diameter. Considering particles as spheres the author distinguishes three kinds of disperse systems: (*a*) dusts, having particles larger than 10^{-3} cm., which settle with increasing velocity in still air and do not diffuse; (*b*) clouds, having particles ranging in diameter from 10^{-3} to 10^{-5} cm., which settle at a constant velocity in still air according to Stokes' law but do not diffuse; and (*c*) smokes, having particles ranging from 10^{-5} to 10^{-7} cm. in diameter, which do not settle at all in still air but diffuse fairly rapidly.

Various common methods of separation of gas particles by settling are discussed. An excellent discussion of flocculation is included. Bag filtration is treated in the conventional manner. In washing methods, the ability of particles of sulphur trioxide and zinc oxide to absorb moisture is discussed in the light of the present-day theory of an adsorbed film of gas around the particle. Electrostatic precipitation is treated from the standpoint of experience with the Cottrell precipitator.

A bibliography of thirty-six references is included in the paper.—Philip Drinker.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Occupational Influences in Tuberculosis Rates. *I. A. Galdston.* Nation's Health, April 15, 1922, 4, No. 4, 226-227.—In the last ten years in New York City tuberculosis has been essentially a man's disease, the male mortality being twice as high as that for women. The reason for this is that the great majority of trades which predispose to tuberculosis are followed, almost exclusively, by men.

Since conditions in industry are often the cause of the development of tuberculosis in the individual, the education formerly attempted in the home and in the school must now be taken to the workshop and factory, the office, the union meeting, and the apprentice school. The economist and sociologist can do his part in reducing the mortality from tuberculosis by efforts to shorten the hours of work, to increase wages to a living standard, and to lighten the fatigue of hard labor.—K. R. Drinker.

Tuberculosis as an Occupational Disease. *Robert T. Legge.* Nation's Health, June 15, 1922, 4, No. 6, 363-364.—In a recent number of the London *Lancet* Professor Benjamin Moore is said to have shown, in an article entitled "Factory Conditions and Phthisis in Great Britain," that urban employment as distinct from urban housing conduces to increase the prevalence of phthisis. It was found that up to the age of 20 both urban males and rural males are healthier than females, and in the case of both sexes urban dwellers are healthier than those in the rural districts; that up to the age of 14 or 15, coincident with the usual beginning of employment in industry, the mortality of females is 50 per cent. greater than that of males; that there is more tuberculosis among males than among females in the cities, the reverse being the case in the country.

Tuberculosis in industry usually follows after a long period of exposure to debilitating conditions. The primary factors are overstrain, unhealthful surroundings, and close contact with operators already infected. In the dusty trades dust is the most important factor; metallic, mineral, vegetable, and animal dusts are all bad. Other factors are the dangerous irritating and toxic fumes, excessive humidity, dampness, extreme heat, cold and darkness. Fatigue due to strain and overwork, and alcoholism increase the risk of infection. Faulty posture, overcrowding, poor ventilation, improper food, and lack of proper rest are all contributing factors to the disease.

The relation of tuberculosis to occupational conditions is definite, and it can be said that occupation is preeminently at fault. The greatest weapon possessed by society in the prevention of the disease is education. The public health nurse is a teacher in health

education, and it will be a happy day when every precinct has a public health nurse who has made a survey of her district.

Another important advancement made in recent years is the extension of nutrition work into industry. The benefits derived from the industrial restaurant have a direct influence in lessening tuberculosis by providing clean wholesome food, properly prepared, and by affording relief of fatigue by relaxation and change of air. The public health center will evolve into a greater and more adequate service for community needs and requirements. Tuberculosis as an industrial disease must be charged to the employer, as far as the necessary means of prevention are neglected. Industrial responsibility does not end with the provision of mechanical exhaust, heating, and ventilating apparatus, but must extend to general interest in providing means of maintaining health.—G. E. Partridge.

Peptone in the Treatment of Anthrax. Jour. Am. Med. Assn., Aug. 26, 1922, 79, No. 9, 755.—Drs. R. F. Vaccarezza, F. F. Inda, and R. Posse have published a paper on the treatment of human anthrax based on their experience in the infectious disease clinic of the school of medicine in Buenos Aires. They treated 204 diseases: fifty-six with anti-anthrax serum Méndez, with a death rate of 19.6 per cent.; ninety-four cases with this serum plus other medication, with a death rate of 20.2 per cent.; twenty-four cases with anti-anthrax bovine serum, with a death rate of 8.3 per cent.; thirty cases with anti-anthrax bovine serum plus other medication, with a death rate of 13.3 per cent.; fifteen cases with normal bovine serum, with a death rate of 20 per cent.; twenty-four cases with normal bovine serum plus other medication, with a death rate of 16.6 per cent.; and fifty-nine cases with peptone alone, with a death rate of 6.67 per cent. The average mortality was 15.8 per cent. The authors concluded that while normal serum has no action experimentally, it has shown curative powers in human anthrax. Its value is virtually equal to that of immune serums. Peptone in muscular injections (from 10 to 20 c.c. a day, 10 per cent. showed a therapeutic potency not inferior to anthrax serum, although naturally it has no specific action.

Treatment of Anthrax. *R. F. Vaccarezza, F. F. Inda* and *R. Posse.* Abstracted as follows from Semana méd., June 1, 1922, 1, No. 22, 865, in Jour. Am. Med. Assn., Sept. 23, 1922, 79, No. 13, 1085.—This long study of hundreds of cases of anthrax treated by various methods asserts that normal beef serum proved as effectual as the specific antiserum, but that its action is merely that of protein therapy. Consequently, the beef serum can be substituted by some substance which does not sensitize, and does not induce serum sickness. Peptone seems best adapted for the purpose, and it proved so satisfactory that in the last six months it has been used exclusively in all cases, even those with septicemia. Nolf's technic is followed: an intragluteal injection once or twice a day of 30 c.c. of a 5 per cent. solution of peptone: 5 gm. of Witte's peptone with 0.5 gm. of sodium chloride in 100 gm. of distilled water. The full data of forty-three cases thus treated are appended.—K. R. Drinker.

The Anthrax Hazard in Pennsylvania Tanneries. *Henry F. Smyth.* Am. Jour. Hyg., July, 1922, 2, No. 4, 346-367.—In 1921, upon the authority of the State Department of Labor of Pennsylvania, a survey of the entire tanning industry of that state was made in order to determine the hazard from anthrax in the handling of hides and skins. It was shown that anthrax is a constant menace to workers in the receiving, soaking, and liming departments of tanneries handling cattle hide and goat skins, and that certification is no infallible protection against the disease. Anthrax was found in more than half the goat skin tanneries sampled and cases were reported in 42 per cent. of the tanneries. In cattle hide tanneries, anthrax has been found by culture in less than 7 per cent., but cases have been reported from almost 40 per cent. Dry hides were found responsible for more cases than green salted hides, and it is, therefore, recommended that if dry skins and hides continue to be imported, provision should be made for disinfecting them at one or more ports of entry by either the Schattenfroh or the Seymour-Jones method, if satisfactory to the tanners, and that the hides thus treated be shipped to the tanneries in the wet salt state.

Lime disinfectant, if used, should be with at least a 10 per cent. calcium oxide suspension from burnt lime for over twenty-four hours (a process which lessens risk but does not entirely eliminate it). The Seymour-Jones method is better than lime if it will give tannable skins, and the Schattenfroh salt and hydrochloric acid method is better than either. To diminish the liability of more or less permanent infestation of soak vats, etc., whitewash should be used on all wood, concrete or metal work about store rooms, soak rooms, etc.

Until tanneries cease to receive infected skins and hides they should be required to provide suitable wash fixtures and shower baths for their employees. Towels, overalls, and workshirts should be disinfected with formaldehyde vapor by the tanner before they are taken from the tannery. Work shoes should not be worn out of the tannery; shoes or boots of rubber and felt with wooden soles that could be disinfected would be best. A further study should be made of the proper disposal of wastes. No dry sweeping should be permitted in stock and store rooms.

The May, 1922, issue of the *Nation's Health* contains an article on this subject by the same author.—G. E. Partridge.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

INJURIES OF THE EYE AND THEIR LEGAL ADJUDICATION. *Viktor Hanke.* Wien. klin. Wchnschr., March 2, 1922, 35, No. 9, 199-203. —Injuries due to accidents in industry are discussed and defined. Clinical features are given in detail. The eye injuries may be divided as follows:

I. Direct traumata of the eyeball.
   (*a*) Injuries due to dull objects.
   (*b*) Injuries due to sharp, pointed objects.
   (*c*) Thermal, chemical, or electrical injuries.

II. Indirect traumata.

Considerations regarding compensability of different types and degrees of eye injuries are given *in extenso.* The greatest compensation for loss of an eye is from 25 to 33 1/3 per cent. of the maximum for eye injuries. According to qualification and age, the compensation for unilateral postoperative aphakia is from 15 to 20 per cent.—B. Cohen.

INDUSTRIAL SURGERY

A REMARKABLE SURGICAL SERVICE. Nation's Health, Feb. 15, 1922, 4, No. 2, 104-106.—A surgical service giving, through centrally located clinics, full-time free treatment to workers all over the country who sustain industrial accidents, treatment rendered by highly specialized industrial surgeons, is the aim of the Liberty Mutual Insurance Company in maintaining its chain of surgical dispensaries.

In order to induce the injured workmen to go to the clinic, the Liberty Mutual not only offers the best of treatment but free treatment is given for the entire period of disability. The aim of the medical department is to shorten the period of disability and to restore the man's earning capacity as soon as possible. It is the policy of the company to pay for the treatment which will do away with the man's disability, rather than to pay the injured man compensation for a long period.

During the last ten years treatment of injured employees has been wonderfully improved, the period of disability has been shortened, and the workmen have learned that the company's aim is their aim.

THE FUNDAMENTAL PRINCIPLES OF ORTHOPEDIC, RECONSTRUCTION AND INDUSTRIAL SURGERY. THE REAL LESSONS OF THE WORLD WAR. *H. Winnett Orr.* Jour. Am. Med. Assn., July 22, 1922, 79, No. 4, 255-257.—This article discusses the lessons of value to orthopedic surgery learned from the war and the importance of their application to cripples both of society and of industry. The importance is stressed of immediate and proper splinting of fractures and of parts affected by infantile paralysis and of the

maintenance of immobilization of injured parts in proper relationship until healing occurs. We have learned, moreover, from our war experience that "there are practically no limits to the possibilities of reestablishment of the individual by the educational and training development of original compensation or vicarious functions."

Common Foot Troubles as Induced by Shoes. *Ralph B. Bettman.* Nation's Health, April 15, 1922, 4, No. 4, 194-196.—Conditions which contribute to common foot troubles are the wearing of poorly fitted socks and stockings and of rubber overshoes which interfere with the natural evaporation of moisture from the foot. The main defects of poor shoes are leather which is too impermeable, high heels, improper "shank" or instep of the shoe, pointed toes, flaring of the shoe so that an "out-toeing" effect is produced, and a purposeful twist in the last so that the foot is slightly rotated, lifting the outer margin upward and allowing the arch to drop a very small amount.

The sequelae of poor shoes are corns, bunions, calluses, and metatarsalgia. Any of these abnormal conditions causes a voluntary or an involuntary effort to spare the part of the foot involved. This means an abnormal gait, speedy fatigue, and a consequent injury to the supporting mechanism of the arches which leads to the development of "weak foot"—a term preferred by the author to that of flat foot.

If recognized early, the great majority of weak feet can be remedied by removing the cause of the abnormal action. A well-fitting and well-constructed shoe will not only prevent the conditions described, but will, in the majority of cases, cure them. The author concludes with an outline of the requirements of a properly constructed shoe. — K. R. Drinker.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

The Effect of Industry upon Alcoholism. *Edgar L. Collis.* World's Health, July, 1922, 3, No. 7, 324-330.—This interesting paper deals with the part which modern industrial life has played, not only in creating a desire for alcoholic beverages when conditions of work are unfavorable, but also in limiting alcoholic tendencies when occupation raises the social position of the worker. The main points brought out are contained in the author's summary:

The development of modern industry saw a marked increase in the consumption of alcoholic beverages.

The regular drive of work continued for long hours, the increase in activity demanded, the custom of paying wages before rest periods, the occasional occurrence of too sudden a rise in wages, have among other things contributed to this increase.

On the other hand, improved health and wealth with general social uplift, shorter hours of toil, provision of facilities for taking food during working hours, and of facilities for personal hygiene, are all industrial influences tending to eradicate inebriety.

Food of Factory Workers in Sweden. *E. Abramson.* Abstracted as follows from Hygiea, Stockholm, May 31, 1922, 84, No. 10, 395, in Jour. Am. Med. Assn., July 22, 1922, 79, No. 4, 338.—The conditions are compared of workers who eat at home and those eating at the free common dining room supported by a certain factory owner. The calories actually consumed, the differences with age, sex and work, the expense per capita, etc., are considered. Fourteen tables give data for comparative research in this line.

Posture and Fatigue. *Theresa Wolfson.* Abstracted as follows from Survey, April 8, 1922, in Jour. Personnel Res., June, 1922, 1, No. 2, 95.—A discussion of a survey of the conditions of seating, illumination and ventilation in the ladies' garment shops in New York City. The survey was made by the Joint Board of Sanitary Control of the industry as a preliminary to the inauguration of an intensive campaign for improvement of posture. One of the most serious conditions found was the use of a motley assortment of chairs and benches ill-adapted, for

the most part, to the stature of the worker. The Board hopes to create an intelligent understanding of the seating problem in the industry and to convince employers that elimination of a great amount of fatigue through the proper handling of this problem is quite as much a matter of good business as the installation of modern machines.

Health Problems Involved in Noise and Fatigue. *Henry J. Spooner.* Nation's Health, March 15, 1922, 4, No. 3, 156-159.—Manufacturers and business men should realize that noise prevention and reduction are a paying proposition, for noise in its cumulative effects probably represents one of the most active causes of fatigue and is, therefore, a source of economic waste. The causes of sounds and noises arising in city streets, factories, and workshops, are analyzed and their remedies discussed.—L. A. Shaw.

The Year's Progress in the Reduction of Noise. *Henry J. Spooner.* Nation's Health, June 15, 1922, 4, No. 6, 368-369.—A standard limit of permissible noise, beyond which it should be considered a public nuisance, is now made practicable by recent improvements effected by A. M. Low in his audiometer. Machinery that is practically noiseless can be devised for almost every purpose. Helical gears, spiral bevel gears, etc., which if mounted on shafts of sufficient stiffness are silent running, should be used. The program should now be: (1) scientific design from the standpoint of noise, substituting pressure for impact wherever practicable; (2) accurate construction and efficient lubrication; (3) observant efficient maintenance.

The article contains a detailed description of Low's audiometer and of the new vibrometer.—G. E. Partridge.

Fatigue Effects as Measured by Sugar Content of Blood. *Buford J. Johnson.* Abstracted from Comparative Psychol., April, 1922, 2, No. 2, 155-171, in Jour. Personnel Res., July, 1922, 1, No. 3, 152.—This experiment was performed for the purpose of studying changes in the sugar content of the blood of children as related to different kinds and amounts of activity. Eight subjects, four boys and four girls (selected because of a relatively low resistance to physical fatigue and the fact that they expended a high degree of effort for such scores as they obtained in their psycho-physical examination) were used throughout the experiment.

Tests for co-ordination, discrimination, memory for digits, and substitution were made. It was impossible to get definite standards as to the normal sugar content of blood for the ages considered because of the variability found in the same individuals in the preliminary examinations. The results obtained after the test series also showed a high degree of variability. A child might show a relatively high sugar content before exercise and then either a slight or marked increase or even a slight decrease after exercise. The author believes that, although conclusions as to the influence of the kinds and amounts of activities upon the sugar content of the blood would be unwarranted by the data, the experiment indicates, nevertheless, a method of investigation that may clarify the concepts of fatigue and lead to a reformulation of the factors involved in fatigue effects.

WOMEN AND CHILDREN IN INDUSTRY

The Problem of the Working Mother. *A. Louise McIlroy.* Nation's Health, March 15, 1922, 4, No. 3, 132-135.—According to the Sex Disability Act, a woman must not be penalized because of her sex. As long as a woman does her work satisfactorily her private life should be just as little the concern of her employer as that of a man. Notwithstanding this act and the morale which it implies, there is a tendency in England today to debar women from employment upon marriage. In dismissing married women from work the industries must lose many highly skilled laborers, and at the same time destroy the incentive of women workers as a whole to become skilled laborers. The injustice and hardship brought about by dismissal in the face of economic stress and financial difficulties may be very severe. The strain and anxiety involved in making ends meet may be

just bearable if a woman can retain her profession or trade.

During pregnancy, work, if not harmful in its effects, should be continued. In the event that full-time work seems to be detrimental, then the work must be graded to meet the temporarily reduced capacity. Reduced remuneration should be supplemented by a maternity endowment fund contributed by the state.—L. A. Shaw.

Occupations of Children. Fourteenth Census of the United States Population: 1920. U. S. Dept. Commerce, Bur. Census, 1922.—The total number of children from 10 to 15 years of age engaged in gainful occupations in the United States was, in 1920, 1,060,858, comprising 714,248 boys and 346,610 girls. The boys reported as gainfully occupied constituted 11.3 per cent. of the total of 6,294,985 boys aged from 10 to 15 years, and the girls 5.6 per cent. of the 6,207,597 girls within the same age limits. The total number of children gainfully occupied was only slightly more than half as large in 1920 as in 1910, the decrease being 46.7 per cent. The gainfully occupied children reported as engaged in agriculture, forestry and animal husbandry numbered 647,309, and those employed in manufacturing and mechanical industries, 185,337. These two groups constituted 61 and 17.5 per cent., respectively, and together embraced nearly four-fifths of the total number of gainfully occupied children. The textile industries employed 54,649 children, or nearly three-tenths of the total number reported for manufacturing and mechanical industries generally.—K. R. Drinker.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

The Scope of Industrial Medicine. *D. Glen Smith.* Indust. Management, June, 1922, 63, No. 6, 370.—The writer thinks that the practice of industrial medicine includes seven chief functions: pre-employment physical and mental examination; periodic examination of employees; the activities of the hospital or dispensary; the prevention of occupational diseases and of infectious and contagious diseases; the sanitary and hygienic supervision of the plant; educational activities, and research.

The pre-employment examination properly separates men into three classes: those who prove to be mentally and physically fitted for any employment they choose or can obtain; those who must be placed subject to certain limitations; those physically or mentally unfit for any employment.

Emergency hospitals, where accidents and acute illnesses of all kinds are given only first treatment, waste space and money, and they should be replaced by the complete and well-equipped dispensary service. The industrial dispensary should be equipped for the proper diagnosis and treatment of all minor and ambulatory surgical accident cases of company responsibility and of all minor surgical and medical cases of personal responsibility in order that employees may be kept at their work until they can conveniently consult private physicians; and for the purpose of securing records of facts for protection against these personal conditions, which occasionally are brought forward as claims.

Ninety per cent. of the activities of industrial medicine are aimed at prevention, and every industrial medical service should develop a satisfactory system of guarding employees against diseases as well as accidents.

Keeping the Human Machinery off the Scrap Pile. *Edward S. Cowdrick.* Indust. Management, June, 1922, 63, No. 6, 324-325.—The writer argues that it is as important to industry to conserve the human factor as it is to conserve machinery. The physical condition of a worker and the factors that affect it are proper subjects for close consideration.

Health conservation, as here discussed, starts with the physical examination. Thorough examinations at stated intervals—conducted by competent internists—and carefully recorded findings are essential. Purely physical ailments may produce mental or temperamental lapses which may be very costly to industry. A high salaried executive may pass months during which, on account of a loss of physical or mental vigor, his services are worth only a fraction of what they cost.

The necessity of understanding and conserving the physical and mental health of men is, therefore, apparent if such loss is to be avoided.—G. E. Partridge.

Medical Services Available for Natives on the Rand Mines. *M. M. Pam.* Lancet, June 10, 1922, 202, No. 5,154, 1,174-1,175.—The account given of medical services available for natives on the Rand Mines borders on the ideal, an ideal seldom attainable. Natives, recruited from their villages, undergo not only thorough medical examination upon reaching Johannesburg, but they are treated for vermin, their heads and bodies are shaved, and their clothes are baked. They are given pneumococcal vaccine and are weighed at the time of employment and every succeeding month. Medical officers are attached to each mine or group of mines; there are dressing stations with attendants in charge; ambulances connect with central hospitals of two hundred or more beds. These hospitals have ample opportunity for bacteriological and chemical work with the South African Institute for Medical Research.

The nursing is carried out by trained white matrons and sisters, with colored probationers; when the latter are well trained they perform routine work excellently. Native "boys" act as ward attendants, orderlies, and interpreters. On returning home, patients who have not fully recovered pass to the care of the medical officer at the nearest recruiting station.

The organization is effective in action as well as on paper, and on the whole, the mining natives on the Rand are well cared for and treated.—E. L. Collis.

Cooperative Medical Aid for Injured Workmen. *Homer D. Dudley.* Nation's Health, April 15, 1922, 4, No. 4, 231-233.—The Industrial Service Bureau of the Kings County (Washington) Medical Society was organized to co-ordinate two plans devised for rendering relief to injured workmen under the Medical Aid Act: one plan permitting industrial plants to enter into contract with individual physicians to furnish medical service; the other plan giving the injured employee the free service of a physician. This bureau, backed by the medical society, makes contracts with employers to render medical and surgical service, discharges its obligations to injured workmen satisfactorily, permitting them free choice of a physician if they desire it, and at the same time apportions the work fairly among the members of the society.

The following is a brief summary of the service which the bureau renders: (1) A twenty-four hour service through a telephone exchange with five trunk lines employing three operators; (2) a choice of any physician from the bureau's list of doctors classified as to their specialties; (3) in the event that the doctor chosen is not immediately available, an emergency service is furnished and the physician selected by the injured workman subsequently takes charge of the case; if no preference is expressed, the bureau furnishes a doctor from a rotating list of physicians who have agreed to be on call for that day; (4) a fully equipped first-aid station with a graduate nurse in charge in each plant or neighboring group of plants employing 1,000 or more workmen; (5) consultation is furnished in all serious cases, consultation when requested, and consultation covering the various specialties whenever indicated; (6) first-aid cabinets with free lectures weekly to designated first-aid men in the various industrial plants; (7) free ambulance and hospital care when needed; (8) private nurses and private hospital rooms in serious cases when advised by the attending physician.—K. R. Drinker.

Value of Comparative Records in Industry. *Robert E. Andrews.* Nation's Health, June 15, 1922, 4, No. 6, 361-362.—There appear to be as yet no accepted standards by which the medical departments of two establishments working along similar lines may classify their risks, accidents, illnesses, lost time, and industrial hazards. The motive for carrying on surveys has been selfish, with little or no thought about the help which they might bring to industry in general, or even to their type of industry in particular. Standardization in keeping and publishing results is necessary, for, in order to obtain the greatest value from medical investigations, it is essential to compare them with others.

The writer has been developing a tentative plan for such standardization of records, using the International List of Causes of Death, making analysis by the Hollerith punch card and by a punch card of the Findex System. A sample card is displayed, and the code is given for disease classification, accident causes, accident types, occupation, nationality, sex status, and absenteeism.

INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

The "Psychosis" of Industry. *Frank M. Harris.* Indust. Management, July, 1922, 64, No. 1, 18-23.—The writer thinks the principles of psycho-analysis may be applied to the urgent problems arising from the present industrial conflict. A state of mental ill-health exists in the collective mind of industry, and this psychosis is the result of a conflict between wish and fact. There are thwarted desires on the part of both labor and capital that require repeated repression, resulting in dejection and discontent which lower the resistance of the industrial body and increase its susceptibility to various kinds of attack.

The cure is to be found in co-operative ownership which substitutes parallelism of interest for opposition of interest. Co-operative ownership replaces the inherent feeling of drudgery with personal enthusiasm for the work; and replaces the contention for collective bargaining of employees with the collective ballot-power of the employee stock-holder. Co-operative ownership, however, is not a system that must be rejected or accepted intact. It is a movement toward an ideal—a movement toward individualizing and humanizing industry.—G. E. Partridge.

Tests for Clerical Occupations. *Cyril Burt.* Jour. Nat. Inst. Indust. Psychol., 1922, 1, 79-81.—The author applied a number of tests to a small group of experienced and intelligent shorthand typists, and correlated the rank obtained in the tests with that supplied by the supervisor: (1) for general office efficiency, (2) for efficiency in typewriting, and (3) for efficiency in shorthand. The correlation coefficients were high, that between general office efficiency, as estimated by the supervisor, and the order for general intelligence, as indicated by the tests, being 0.79. The shorthand test yielded the same coefficient, but that for typing was only 0.60. As the result of comparing the tests, it appeared that mixed sentences, opposites, and completion were better tests of general efficiency than definitions, synonyms, analogies, and spelling.

The typists were sorted into four groups, termed excellent, good, tolerable, and failures, and by determining the marks obtained by each group in the tests, standards of efficiency were obtained.—H. M. Vernon.

What Is Personnel Research? *Robert M. Yerkes.* Jour. Personnel Res., June, 1922, 1, No. 2, 56-63.—Personnel research is the study, by scientific methods, of man in relation to the trades, arts, and professions. Only recently has attention been directed to this problem, as the idea of increasing efficiency through the mechanization of industrial operations has been carried into the sphere of human labor, while at the same time labor under the process of mechanization has become more and more self-conscious and defensive, thus causing mutual suspicion and dislike on the part of employer and laborer. There emerges slowly in this situation the belief that personnel research may point the way to adjustment or to a better system.

The proper unit of industry is the person, not the machine; the principal aspects of man in this capacity are three: physical, mental, and moral. Personnel research must be concerned with all available methods of studying these qualities and relations of men. Personnel research has to do also with the hygiene of occupational and personal life, with occupational diseases, with the health, vitality, safety, and comfort of the worker.

In regard to investigation of mentality, there are two groups of mental measurements that are especially important: measurements of intelligence, and measurements of temperament and emotional traits. Much has already been done in the study of the rela-

tions of the body of the worker to industrial demands, and now the mental aspects of the worker's nature are being considered. But there is more than that: the person may be misplaced in choosing a vocation because of lack of character and moral constitution, so there is urgent demand for the measurement of other aspects of mind than the intellectual.

There are also three essential categories of value as of personal traits: the material, the mental and the spiritual. Industrial life must be made to provide for the development of every personality in respect to all values.

Forms, Records, and Reports in Personnel Administration. *C. N. Hitchcock.* Univ. Chicago Press, 1922, pp. 128. — The purposes of this collection of forms and records are two: to suggest the type of data in the field of industrial relations which the management of a business should have at its disposal, the records necessary for their collection, and some possible methods of presenting them for administrative use; and to illustrate the normal daily routine procedure of a personnel department.

The Medical Aspects of Personnel Work. *Robert E. Andrews.* Nation's Health, April 15, 1922, 4, No. 4, 228-230. — Proper correlation of the medical and the employment departments is of great assistance in solving many of the placement problems which arise in an industry. Each new employee should be given a physical rating by a qualified industrial physician, and the data in regard to him turned over to the employment manager. In this way three sources of danger are eliminated: danger to the worker himself through fainting or epileptic seizures in the neighborhood of moving machinery; danger to other workers from contagion: and, lastly, danger to property from the mental unbalance of a worker.

The problem of the pregnant woman is an extremely important one in certain industries. In the textile shops of the Ludlow Manufacturing Associates, for example, more than 10 per cent. of the "help left" during a year are obstetrical cases. The industrial physician should be the employment manager's right hand in determining whether pregnant women are harming themselves and are slowing production by being kept too long on the job, and also whether, as efficient workers, they are physically ready to return to work when they reappear after confinement, seeking their old jobs.

The medical and employment departments can advantageously co-operate with each other in handling such problems as the betterment of industrial relations, the placement of the industrial cripple and of minors at suitable work, the treatment of requests for transfer because of fancied grievances, the employment of widows with dependents, the finding of temporary jobs for convalescents, and the handling of phobias and of psychological conditions arising from monotonous work.—K. R. Drinker.

A Test for Use in the Selection of Stenographers. *M. A. Bills.* Abstracted from Jour. Applied Psychol., Dec., 1921, 5, No. 4, in Jour. Personnel Res., June, 1922, 1, No. 2, 92.—This reports further work with tests for stenographers and checks results given in a former issue of the *Journal of Applied Psychology.* Test VI, an intelligence test devised by the Bureau of Personnel Research, gives a critical score of 60, that is, those scoring below 60 are failures. To check the results, the test was given to two other groups, confirming the conclusion that the placing of the critical score was correct.

INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

Making Happiness a By-Product of Industry. *George W. Hanley.* Indust. Management, May, 1922, 63, No. 5, 287-291.—The whole personnel of the American Rolling Mill Company in Middletown, Ohio, is organized into an association, the members of which work together to promote everyone's happiness. The association is governed by a board of directors elected by popular vote from different departments of the mill. It has purchased and equipped a large building for use as a clubhouse and it maintains athletic

grounds, etc. A band has been organized and trained to a high degree of skill, and the association also has an orchestra and chorus. Public concerts are given; there are entertainments, dances, athletic contests; and many other club acitivities are carried on.

Advantages of a Model Industrial Cafeteria. *Lee K. Frankel.* Nation's Health, April 15, 1922, 4, No. 4, 219-221.—This article describes in detail the working organization of the cafeteria of the Metropolitan Life Insurance Company in New York City, a cafeteria in which over 6,000 employees are served daily with a free table d'hote luncheon.—K. R. Drinker.

A New Kind of Factory Vacation Plan. Abstracted from Labor Forecast (Babson's), July, 1922, in Factory, Sept., 1922, 29, No. 3, 304, 306.—The American Multigraph Company of Cleveland installed a plan of employee representation patterned on the United States Government, in which the officers of the company formed the Cabinet, the department heads a body called the Senate, and the bulk of the employees the House of Representatives. The two latter bodies together made up the Congress. This Congress formulated a vacation plan which is used by the company.

Vacation periods are based upon length of service in the company; an employee who has worked for five years or more is given a vacation of two weeks; an employee who has worked at least two years, one week. If an employee uses his vacation period for any other purpose than that of taking a vacation, measures are taken to penalize him for this breach of the vacation arrangement.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

Labour Legislation Arising out of the International Labour Conference. Internat. Labour Office, Official Bull., Aug. 9, 1922, 6, No. 6, 253-289.—A summary is presented of the measures taken to give effect to the Draft Conventions and Recommendations adopted by the 1919, 1920, and 1921 sessions of the International Labour Conference.—M. C. Shorley.

New York Labor Laws Enacted in 1922. New York State, Dept. Labor, Special Bull., No. 111, May, 1922, pp. 38.—This pamphlet contains New York Labor Laws for 1922 pertaining to public safety, and hygiene; workmen's compensation; court jurisdiction of offenses; woman, child, prison, and hospital labor; and railroad and public employees.

The Protection of Blind Workers. Internat. Labour Office, Official Bull., May 24, 1922, 5, Nos. 20-21, 2-8.—The International Labour Office presented to the General Conference on the Freedom of Communications and Transit, held at Barcelona, a request for an international agreement concerning facilities for travelling for the blind.

It was recommended that national administration of transportation services should jointly give special consideration to the position of the blind travelling in the exercise of their vocation, and that they should particularly consider the possibility of authorizing blind workers thus travelling to be accompanied by a guide without having to pay two fares.

A questionnaire was issued; and reports were given from twenty-four countries showing that at present there is a wide variety of practices, from total lack of special privileges to blind persons, as in Greece, Japan, and Lithuania, to liberal provisions for them such as are made in Australia, France, and several other countries.—G. E. Partridge.

Workmen's Compensation. U. S. Bur. Labor Statis., Month. Labor Rev., June, 1922, 14, No. 6, 156-159.—This is a brief report regarding workmen's compensation from four states: Indiana, North Dakota, Pennsylvania, and Virginia. A summary of accident statistics is given and of the payments in compensation. Indiana reports 263 fatal accidents during the year 1920-1921, Pennsylvania 1,924, Virginia 141. The total number of accidents in Pennsylvania from January, 1916, to the end of 1921 is given as 1,136,060, of which 16,166 were fatal and 110,193 serious.

Spirochetal Jaundice and Workmen's Compensation. *J. Shürer.* Abstracted as follows from Med. Klin., April 23, 1922, 18, No. 17, 533, in Jour. Am. Med. Assn., July 1, 1922, 79, No. 1, 85.—The man of 62 developed fatal spirochetal jaundice two weeks after a fall into a cesspool. An analogous case was published by Stirl. The right to workmen's compensation was recognized in both cases.—K. R. Drinker.

Workmen's Compensation for Inoculation with Plague. Jour. Am. Med. Assn., July 29, 1922, 79, No. 5, 379.—The *Medicina Contemporanea* quotes in full the decision rendered recently, by the Lisbon court that deals with workmen's compensation cases, in the case of an attendant at a hospital morgue. His duties included assisting at necropsies, and he died eight days after being scratched on the finger during the necropsy of a plague victim. The lesions and bacilli of plague were found in him after death, and the court decreed that a compensation based on the salary the man had been getting should be paid to the widow and two children.

The Portuguese government granted a pension to the family of Professor Pestana under similar conditions; death followed contracting of plague from a cadaver. Our exchange queries, "And what about the physicians and nurses who have lost their lives from professionally acquired plague, typhus or pneumonia, during these last two years since the law on workmen's compensation has been in effect?"

A Neglected Phase of Workmen's Compensation. *E. H. Lewinski-Corwin.* Nation's Health, March 15, 1922, 4, No. 3, 155-156.—The past ten years have proved the compensation laws dealing with industrial accidents in the United States to be, on the whole, a success. Too much stress, however, has been laid on economic relief and on the reduction of the frequency of accidents, and altogether too little thought has been given to the adequacy of medical provision for the victims of the accidents. There is need of a thoroughgoing study of the problem of administration of the medical benefit in workmen's compensation.—L. A. Shaw.

Pensions. Abstracted from L'Usine, Paris, Jan. 28, 1922, in Factory, May, 1922, 28, No. 5, 564, 566.—Pensions for old and incapacitated workers have been established by a number of French manufacturers. According to one plan workmen contribute a minimum of 1 per cent., and the owners contribute a like amount until ten years of service have been completed, when their contribution is increased to 1.5 per cent. After 20 years the employer's contribution is increased to 2 per cent. To encourage thrift a larger proportionate contribution is made by the employer as the employee's contribution increases. After five years of continued service, the payments of the owners remain unrestrictedly the property of the workmen.

Comparison of Workmen's Compensation Insurance and Administration. *Carl Hookstadt.* U. S. Dept. Labor, Bur. Labor Statis., Bull. No. 301, April, 1922, pp. 194.—As a result of the demand of state legislators and others for information regarding the relative merits of different types of insurance under workmen's compensation, this investigation was begun in 1919, and completed in 1920. The points upon which information was particularly sought were the relative costs, security, and service of the various types of insurance carriers. The question of costs included both the cost of insurance and the cost of administration. The question of security covered security both to employers and to injured workmen. In regard to service, three tests were taken into consideration: (1) promptness of compensation payments, (2) adequacy or liberality of payments, and (3) accident prevention work. An additional study was made of the administrative procedure of state industrial commissions and funds, especially in regard to methods of accident reporting and claim procedure.

The Physician and Workmen's Compensation. *George E. Tucker.* Nation's Health, Feb. 15, 1922, 4, No. 2, 101-104.—There is an almost uniform agreement by legislators and parties at interest as to the purpose of workmen's compensation; yet there is so little similarity between the compensation laws of adjoining states, even when

the industrial conditions would seem to call for the same standard, that the probability of attaining any degree of legislative uniformity now seems very remote.

Among legislators, and even among physicians, when medical aid provisions have been considered, palliation instead of restoration has been allowed to become the object of their effort. Whatever shortcomings there are in the results obtained from the application of the compensation principle in this country and the part taken by physicians in connection with its operation, they may be attributed to faulty legislation and misunderstandings, and the cure will follow further study, investigation, education, and legislative amendments.

Particular emphasis is laid upon the fact that palliative measures are in the end wasteful, and that a consideration of physicians' fees, hospital expenses, and compensation to the disabled man during convalescence must not stand in the way of the most effective possible recovery.—L. A. Shaw.

Desirable Improvements in the New Jersey Workmen's Compensation System. *E. H. Downey.* Am. Labor Legis. Rev., June, 1922, 12, No. 2, 115-117.—This is a review of the report of the committee on workmen's compensation of the New Jersey State Chamber of Commerce, and it reinforces the claims made in that report. The plea is that the whole cost of work injuries ought to be borne by industry, whereas now in the state of New Jersey (and to a greater or less extent in every state) the cost is thrown upon the injured workman. New Jersey pays the injured workman not more than $12 per week, beginning with the tenth day after disability: for temporary disability industry bears 25 per cent. of the cost only. For permanent total disability, New Jersey pays $12 a week for 400 weeks. In case of death compensation is paid to the widow and children for not more than 300 weeks. "For this state of affairs there is no excuse in ethics, economics, or politics." The cost of 100 per cent. compensation for all work injuries would not amount to 10 cents on a pair of shoes. A decent and adequate scale of benefits would impose no hardship on the employer or on the consumer.—G. E. Partridge.

Occupational Diseases Excluded from Operation of Oregon Workmen's Compensation Act. U. S. Pub. Health Ser., Pub. Health Rep., June 2, 1922, 37, No. 22, 1314.—"It has been decided by the Supreme Court of Oregon that under the workmen's compensation act of that state an occupational disease is not a 'personal injury by accident,' and therefore is not compensable. The disease in question in this case was lead poisoning."—B. Cohen.

New York State Labor Law, with Amendments, Additions and Annotations to August 1, 1922. Pp. 143. New York State Miscellaneous Labor Laws, with Amendments, Additions and Annotations to August 1, 1922. Pp. 165. New York State Workmen's Compensation Law, with Amendments, Additions and Annotations to August 1, 1922. Pp. 112.—These pamphlets are listed for the benefit of interested readers.—M. C. Shorley.

So-Called Traumatic Displacements of the Uterus. *Harry E. Mock.* Jour. Am. Med. Assn., Sept. 2, 1922, 79, No. 10, 797-801.—The author discusses in this paper the frequency of so-called traumatic displacements of the uterus in personal injury claims, and contrasts with it the great infrequency of the actual occurrence of this condition. He then cites the opinions of various physicians and surgeons, obtained by questionnaires and by direct inquiry, as to the rarity of traumatic displacement of the uterus, and reviews the statements of various gynecological authorities upon trauma as a cause of displacement. Conclusions derived from the material presented are as follows:

1. Acute temporary displacements of the uterus may follow trauma, but the symptoms are so severe that relief is secured immediately, and the disability is only of short duration.

2. Permanent uterine displacements are never due to trauma *per se.*

3. Trauma may cause some exaggeration of an existing, unrecognized displacement, but careful study will demonstrate that the chief etiologic factors are some combination of the pre-existing conditions.—K. R. Drinker.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

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CONTENTS

GENERAL

THE INDUSTRIAL PHYSICIAN'S COMMUNITY RELATIONS. Nation's Health, Sept. 15, 1922, 4, No. 9, 549-550.—This article summarizes the findings of a committee of three appointed to report to the meeting of the American Association of Industrial Physicians and Surgeons upon the relations of the industrial medical practitioner to the activities of the non-industrial physicians and of other community health agencies.—L. A. Shaw.

REPORT OF THE COMMITTEE ON INDUSTRIAL HYGIENE, STATE AND PROVINCIAL HEALTH AUTHORITIES. Am. Jour. Pub. Health, Oct., 1922, 12, No. 10, 839-840.—In its report to the 1922 Conference, the Committee submitted for consideration three questions and tentative answers thereto as follows:

1. Is industrial hygiene a proper function for a state department of health? The question is answered in the affirmative, and reasons are given.

2. Is industrial hygiene of sufficient importance to give it a distinctive position in the organization? The answer suggested is that industrial hygiene be made a subdivision of either the bureau of general administration or medical welfare, employing for the personnel assignments persons from the engineering, nursing, sanitary inspection, statistical, and other bureaus.

3. What should a state department of health program for industrial hygiene incorporate? In answer, a program is submitted including the following suggestions:

(*a*) That contact with public factory inspection, labor and compensation agencies be secured.

(*b*) That education and publicity work for employers, employees, and the community be carried on.

(*c*) That information service and standard methods be established.

(*d*) That service in the form of demonstrations, inspections, research, medical and nursing consultations, etc., be installed.—Henry F. Smyth.

Proceedings of the Industrial Relations Conference, October 24-27, 1921. Penn. Dept. Labor and Indust., Ser. of 1922, 9, No. 2, pp. 252.—This pamphlet contains a very considerable number of brief papers presented at the Industrial Relations Conference held in October, 1921, under the auspices of the Department of Labor and Industry of Pennsylvania, together with the discussion following these papers. The articles of interest to industrial hygiene are "Employment of Minors," by Mary Anderson; "The Massachusetts Forty-Eight Hour Week vs. the Eight-Hour Day," by Ethel M. Johnson; "A Plan of Industrial Clinics for Philadelphia," by Dr. Mervyn Ross Taylor; "The Doctor an Educator and Promoter of Efficiency," by Dr. W. Seymour White; "Occupational Clinics for Industrial Service and Research," by Dr. Edward E. Mayer; "Rehabilitation of the Industrial Cripple," by Lewis T. Bryant, and "Progress in Compensation," by Robert E. Lee.—K. R. Drinker.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

The Treatment of Carbon Monoxide Asphyxia by Means of Oxygen + CO_2 Inhalation. *Yandell Henderson, Howard W. Haggard,* and *Stuart Scott.* Jour. Am. Med. Assn., Sept. 30, 1922, 79, No. 14, 1137-1145. —This article, which constitutes Report 1, of the Commission on Resuscitation from Carbon Monoxide Asphyxia, organized at the request of the American Gas Association, reports investigations both in the field and in the laboratory on the treatment of carbon monoxide asphyxia by the inhalation of a mixture of oxygen and of 5 per cent. carbon dioxide. The authors first discuss the ineffectiveness of oxygen alone and then point out the value of adding carbon dioxide to the oxygen in order to stimulate vigorous breathing so that oxygen may be drawn into the lungs and carbon monoxide "washed out."

Laboratory experiments on animals and on men are cited to show the speed (within thirty minutes) with which high concentrations in the blood of carbon monoxide are reduced to harmless limits under oxygen + carbon dioxide inhalation. This speed of elimination is contrasted with the much slower elimination of carbon monoxide which occurs in patients left untreated or treated with oxygen alone.

The H-H. inhaler, the apparatus used for administering oxygen + carbon dioxide to gassed victims, is next described and directions for its use given.

The article ends with a report of the results of this type of treatment on a number of patients poisoned with illuminating gas in New York City. The author's conclusions with regard to the proper treatment of illuminating gas poisoning are as follows:

1. Manual artificial respiration by the prone pressure method should be employed, when respiration has stopped, to start spontaneous breathing. This object may be assisted by administering oxygen + carbon dioxide simultaneously.

2. Inhalation of oxygen and 5 per cent. carbon dioxide, by causing a very full ventilation of the lungs, rapidly eliminates carbon monoxide from the blood and thus terminates the condition of asphyxia. This treatment is highly effective, inducing rapid and complete recovery, if applied early enough. It requires merely general medical supervision, and may be safely and efficiently carried out by intelligent men of the type composing the emergency crews of a city gas company.

3. Until more definite knowledge has been obtained regarding the conditions in the lungs, brain and elsewhere, subsequent to gassing, and until treatment can be based on such knowledge and has been tested experimentally, it is inadvisable to apply any spe-

cific treatment in post-asphyxial gassing cases. The evidence here reported indicates that oxygen + carbon dioxide inhalation and rapid elimination of carbon monoxide greatly decreases the liability to nervous and pulmonary asphyxial sequelae.

The Hazards of Carbon Monoxide Poisoning. *Yandell Henderson.* Nation's Health, Oct. 15, 1922, 4, No. 10, 607-609.—The health hazards due to the exhaust from automobiles have of late become so frequent that they are receiving very serious attention. The investigation of this problem includes (1) a consideration of the amount and chemical composition of the exhaust gas produced, and (2) the physiological effects of the substances in exhaust gas and the amounts which may be tolerated without injury. It has been shown (1) that practically the only toxic constituent in the exhaust gas is carbon monoxide; and (2) that carbon monoxide has no other toxic characteristic than its combination with hemoglobin and its consequent exclusion of oxygen. The symptoms of carbon monoxide poisoning of varying degrees of severity are discussed, together with the treatment by means of the administration of oxygen with an admixture of carbon dioxide, which proved far more effective than straight oxygen.—L. A. Shaw.

Automobile Exhaust Gas as a Health Hazard. *Yandell Henderson.* Boston Med. and Surg. Jour., Aug. 3, 1922, 187, No. 5, 180-183. —In the treatment of carbon monoxide poisoning it is suggested that the administration of small amounts of carbon dioxide in conjunction with oxygen inhalations are highly valuable if not life-saving. The object of the carbon dioxide is to stimulate pulmonary ventilation. As a subcommittee of the American Gas Association commission on resuscitation from gas poisoning, Henderson and Haggard have tested this method in New York City. The results indicate that a deeply asphyxiated patient, who can be reached within a half-hour—and the utmost speed at this time is essential—and who is then given inhalations of oxygen containing 5 per cent. carbon dioxide, can be practically freed from carbon monoxide within thirty to forty minutes. Frequently consciousness returns within this time.—B. Cohen.

Benzol Poisoning: Its Occurrence and Prevention. *Charles F. Horan.*—In an address before the National Safety Council in Detroit on August 30, 1922, Charles F. Horan gave an outline of certain points of the chemistry, manufacture, and uses of benzol; a chronological account of cases of poisoning reported; and a discussion of the mechanism of benzol poisoning and individual susceptibility.

The author concludes that benzol can be and is safely used in the rubber industry, but that frequent and regular physical examination of the worker and adequate ventilation for removal of the fumes are essential.—Philip Drinker.

Tetrachlorethane Poisoning. *Frois.* Abstracted from Bull. de l'Acad. d. méd., July 11, 1922, 88, No. 28, 40, in Jour. Am. Med. Assn., Sept. 16, 1922, 79, No. 12, 1000.—Frois explains that artificial ventilation stirring up the air is not enough to prevent the toxic action from absorption of the fumes of this solvent. In twelve fatal cases reported in England the liver and kidneys suffered most and the blood did not show any alteration. He explains that the fumes are heavy, and the best means for prophylaxis is to draw them down and out with an exhaust ventilator. By this arrangement the manufacture of artificial pearls, for instance, can be carried on without danger of serious harm.—K. R. Drinker.

Constructive Industrial Hygiene in the Indiarubber Industry. *C. A. Klein.* Jour. Soc. Chem. Indust., Aug. 15, 1922, 41, No. 15, 325R-328R.—This article contains a critical review of recent British legislation which became effective May 1, 1922. This governs vulcanization and treatment of rubber involving the use of toxic volatile solvents such as benzol, and compounding processes in which lead or lead compounds are used. The author shows that there has been a decrease in the number of cases of poisoning in spite of the greatly increased use of these substances. This decrease is due to the enforcement of ventilation rules whereby the toxic vapors are drawn off by fans, and lead dusts are removed in a somewhat similar manner. Mention is made of the use of a mixture of eighty parts of lead compounded with twenty

parts of pure rubber. This mixture is homogeneous, is sold in sheet form, is ready for direct incorporation with the other ingredients on the rolls, and offers the hygienic advantage of causing no dust.—Philip Drinker.

Report of Health Hazards Committee on Dangerous Materials Common to the Rubber Industry. *Charles F. Horan.*—In a report presented at the meeting of the National Safety Council in Detroit on August 30, 1922, dangerous materials listed were: aniline, antimony, benzine, benzol, carbon disulphide, carbon tetrachloride, hexamethylenetetramine, lead, para-nitrosodimethylaniline, para-phenylenediamine, sulphur chloride, and thiocarbonilide. Under each substance, to an extent varying with the importance of the substance in the rubber industry and with the known toxicological facts, were given facts regarding dangers, symptoms, severe cases, subacute and chronic poisoning, measures of relief, and prevention.—Philip Drinker.

Calcium Nitride Poisoning. *E. Hesse.* Abstracted as follows from Med. Klin., April 9, 1922, 18, No. 15, 461, in Jour. Am. Med. Assn., June 17, 1922, 78, No. 24, 1935.—Hesse reports experimental research with calcium nitride which is being used more and more extensively as a fertilizer. It is liable to cause a dermatitis, to injure the respiratory apparatus and to induce an affection resembling the hyperemia of amyl nitrite, plus malaise and acceleration of the pulse. The attack lasts only a few hours and leaves no traces. Its special feature is that it develops only when alcohol is taken, and the attack can be brought on by giving the essential element of the calcium nitride, cyanamide, with alcohol. No antidote is known. Prophylaxis is the main thing in factories, good ventilation, keeping down the dust by adding oil, and protecting with a mask against inhalation, but, above all, by refraining from alcohol.—K. R. Drinker.

Tar Cancer. *H. Jordan.* Abstracted as follows from Ztschr. f. Krebsforsch., Aug. 10, 1922, 19, No. 1, 39, in Jour. Am. Med. Assn., Oct. 14, 1922, 79, No. 16, 1373.—Jordan comments on the fact that the mechanical injury from coal dust does not induce cancer while there is no mechanical injury from coal tar, with which cancer is common, as also with soot. He reports that coal tar induced cancroids in four months in 100 per cent. of the white mice he treated with it. The residue of the tar after distillation induced production of the precancerous condition in half the time required for the whole tar.

The Detection of Small Amounts of Lead in the Urine. *O. Schumm.* Abstracted from Ztschr. f. physiol. Chem., 1922, Vol. 118, 189, in Med. Science, Aug., 1922, 6, No. 5, 431.—The applicability of several methods for the detection of small amounts of lead in the urine in cases of lead poisoning is examined. The author finds the most satisfactory method to be that of Meillère, modified as follows: 15 c.c. of 25 per cent. hydrochloric acid and 0.4 gm. of copper sulphate are added to $1\frac{1}{2}$ liters of urine. Hydrogen sulphide is then passed through the liquid, first at ordinary temperature and then at about 40–50° C. The precipitate is collected, extracted with nitric acid, and the extract electrolyzed at a tension of about 4 volts and a current strength of 0.5 amperes. An electrolytic separation of the copper and lead occurs, the latter metal depositing on the anode, an extract of which will give typical reactions of lead. The method serves to detect amounts of the order of 0.1 mg. of lead per liter.—M. C. Shorley.

Lead Poisoning. *Wade Wright.* Boston Med. and Surg. Jour., Aug. 31, 1922, 187, No. 9, 328-331.—Some statistics are given from the Industrial Clinic of the Massachusetts General Hospital. Nearly 2 per cent. of all patients admitted to the outpatient department were employed at work which exposed them to lead. Of this exposed group, about 10 per cent. presented evidences of industrial lead poisoning. Seven per cent. of a large group of recently recorded lead cases were of non-industrial origin.

In the discussion of this paper, Dr. John Key has taken up the pathology of lead poisoning and particularly of stippling in the blood.—J. C. Aub.

Gout and Lead Poisoning. *A. M. Brogsitter* and *H. Wodarz*. Abstracted as follows from Arch. f. klin. Med., May 5, 1922, 139, No. 3-4, 129, in Jour. Am. Med. Assn., July 8, 1922, 79, No. 2, 169.—In the eight cases of chronic lead poisoning and six of gout described here, there was nothing in the history to indicate that there had ever been an acute hemorrhagic nephritis, so the necropsy findings can be ascribed to the lead or the gout. Deposits of urates were found in only two cases, but the blood vessels showed pronounced changes in both the lead and the gout cases, as also the glomeruli; the findings in the tubuli differed materially.

Encephalopathy with Ocular Complications Probably Due to Lead Poisoning. *Albert C. Sautter*. Am. Jour. Ophth., June, 1922, 5, No. 6, 468-470.—This is the report of a case of probable lead encephalopathy. The diagnosis was based largely upon occupation, stippling in the blood, and mental symptoms of headache, diplopia, and drowsiness with rare convulsions. There was no lead line, and no lead was found in the urine.

The eye examination at first showed a low degree of neuroretinitis. Later examination revealed that this became more marked, with many hemorrhages and exudations. Within six weeks this action subsided and the fundus became essentially normal. A transitory paresis of the right external rectus muscle and contraction of the visual fields also occurred.

As collected statistics demonstrate, eye symptoms due to lead poisoning are relatively very infrequent.—J. C. Aub.

Regulation on the Use of White Lead. Jour. Am. Med. Assn., Sept. 16, 1922, 79, No. 12, 976. — The government of Tunis has informed the International Labor Office (League of Nations) of a recent decree regulating the use of white lead. This decree prohibits, after one year from the date of promulgation, the use of white lead, in both the external and the internal painting of buildings. White lead may not be used in other operations except in the form of paste. Hand work is forbidden, as well as dry scraping and dry rubbing down, and in all painting operations in which white lead is used the workers must be provided with clean overalls. Violations of this order will be subject to penalties.—K. R. Drinker.

DUST HAZARDS AND THEIR EFFECTS

A New Instrument for Sampling Aerial Dust. *L. Greenburg* and *G. W. Smith*. U. S Bur. Mines, Rep. Investigations, Ser. No. 2392, Sept., 1922.—A two-hole rubber stopper is fitted into the top of a tall, conical, flat-bottomed precipitating flask of 500 c.c. capacity. Into one hole is fitted the exhaust leading to a flow meter and suction apparatus A glass tube (5/8 inch by 9½ inches) for admission of the dusty air enters the other hole of the stopper. The bottom of this inlet tube is flat and pierced by fifteen holes, each approximately 0.8 mm. in diameter. By means of three lugs the bottom of the tube is kept at a distance of 0.8 mm. from the bottom of the flask.

Three hundred cubic centimeters of water are used in the flasks, the sampling and subsequent analyses being carried out in much the same manner as in the Palmer apparatus.

A brief table of efficiencies shows that this apparatus compares very favorably with the Bureau of Mines sugar-tube method. The details are too meager, however, to permit one to form an opinion on the practicality of the apparatus for general use.

Standard Method of Testing Dust Removal Efficiencies of Air Washers. *O. W. Armspach* and *Margaret Ingels*. With a New Method of Making Air Dust Determinations. *F. Paul Anderson* and *O. W. Armspach*. Jour. Am. Soc. Heating and Ventilating Eng., July, 1922, 28, No. 5, 533-544.—The authors give examples to show errors caused by counting dust particles by the usual method with the Sedgwick-Rafter Counting Cell. A new apparatus is described in which air, at a constant rate of flow, is drawn through a cloth filter and the pressure difference, as shown by a manometer, on the two sides of the filter gives a relative indication of air dustiness. Specifications and further tests with this apparatus

on various dusts are to form the subjects of subsequent articles.—Philip Drinker.

Summary of Investigations of Dust and Ventilation in Metal Mines. *D. Harrington.* U. S. Bur. Mines, Rep. Investigations. Ser. No. 2374. July, 1922.—For several years the Bureau of Mines has studied dust and ventilation in metal mines as affecting the health, safety, and efficiency of underground workers. A summary of the investigations which have been made is included in this report, together with a bibliography.

Free silica dust is considered the most dangerous to health, and other dusts are definitely known to have harmful effect; probably any finely divided, insoluble dust —including that of coal—breathed in large quantities for continuous periods of time by underground workers, will ultimately result in bronchitis, miners' asthma, lead poisoning, or miners' consumption, or will predispose workers to pneumonia or tuberculosis.

Questions yet to be solved are the following: Why one dust is more harmful than another; why dust of a certain chemical or mineralogical composition is harmful in one mining locality and relatively harmless in another; the best practical measures to avoid the ill effects of harmful dusts; how best to cause air to circulate with maximum efficiency and minimum cost to places where metal miners work; the quantities of air necessary under varying conditions; and the physiological effects due to various kinds of gases, degrees of air vitiation, and ranges of temperature and humidity.—M. C. Shorley.

The Pathology of Miners' Phthisis. *W. E. Gye* and *E. H. Kettle.* Lancet, Oct. 21, 1922, 203, No. 5173, 855-856.—This article throws further and important light upon the effect exerted upon living tissues by silica, a subject which the authors have already done so much to elucidate. Two questions are asked: (1) Why is silica, conspicuous and possibly alone among common dusts, capable of inducing extensive fibrosis? (2) How does the silicotic fibrosis aid the establishment of tuberculosis?

Experimental evidence is quoted in favor of answering the first question by the reply that silica causes fibrosis by acting chemically on the tissues and not in virtue of its physical properties; and of answering the second that silica dust and the tubercle bacillus, when concentrated in small foci, act together as irritants and set in motion a series of reactions on the part of the lung which neither alone is capable of initiating. The authors have shown that (*a*) colloidal silica is a cell poison; (*b*) colloidal silica is the most easily formed of silica soluble forms, the circulation of silica in nature depending upon this; and (*c*) living material (soil bacteria) is able to break up mineral silicates with formations of soluble silica.

Injections of soluble silica or silica dust in the tissues of animals cause the formation of fibrosis; the only obvious difference is that the reaction is more rapid and more transient with colloidal silica. These findings support the view that SiO_2 becomes soluble by hydration in the tissues. On account of their high degree of natural immunity to tuberculosis, mice were used for experimental purposes. When silica was introduced along with tubercle bacilli, the silica caused a necrotic coagulum in the tissues in which the bacilli proliferated abundantly. In other words, the silica broke down locally the immunity against tubercle. Soluble silica circulating in the blood stream was not found to influence materially a generalized tuberculosis, neither hastening nor retarding its progress. Apparently the growth of tubercle bacilli is promoted only where the poison is sufficiently concentrated to form local areas of tissue destruction.

The pathological explanation put forward of tuberculous silicosis in miners is that silica dust when inhaled exerts a destructive action on pulmonary cells whereby foci of necrosis are produced in which tubercle bacilli can multiply, while disorganization of the lymphatic drainage of the lung contributes to the process.—E. L. Collis.

The Problem of Dust Phthisis in the Granite Stone Industry. *Frederick L. Hoffman.* U. S. Dept. Labor, Bur. Labor Statis., Bull. No. 293, May, 1922, pp. 178.—For the present purpose the results here presented are largely limited to the statistical aspects of the problem, though equally urgent is a comprehensive descriptive account

of shop conditions and processes of manufacture bearing directly upon health hazards. The results, in a general way, may be summarized as follows:

1. The granite-stone industry is carried on by wage earners who, broadly speaking, live under sanitary conditions above the average, so that possibly unfavorable environmental factors are of decidedly secondary importance.

2. The housing conditions under which granite workers live are also above the average, so that in this respect the environmental factors are favorable to a low mortality rather than otherwise.

3. Anthropometric records clearly establish the fact of a superior physique, indicative of a higher degree of disease resistance, as determined by a relative weight above the average. From this point of view, therefore, granite workers should experience a relatively low mortality from pulmonary tuberculosis instead of a mortality decidedly above the average normal to industrial occupations.

4. Granite workers, considered by specific occupations, show wide variations in tuberculosis frequency, the excess in the death rate being most marked among the men employed in granite-stone cutting, it being especially severe among the men employed in the use of pneumatic tools. Certain occupations, such as polishing, tool sharpening, bed setting, etc., do not show a marked excess, if any, in the mortality from pulmonary tuberculosis, clearly indicating that the risk is practically proportionate to dust exposure.

5. Compared with the normal death rate of adult males of the State of Vermont, or of New England, the mortality from pulmonary tuberculosis among granite-stone workers has increased enormously during the last two years, as contrasted with a diminishing mortality in the population at large.

The same conclusion applies to non-tuberculous respiratory diseases, for it is shown that the mortality from bronchitis, pneumonia, and asthma is also on the increase among granite cutters, in contrast with a diminishing rate of frequency among adult males of the general population.

While normally the rate of tuberculosis frequency diminishes with increasing adult age, the contrary is shown to be the fact as to granite cutters, among whom the death rate from pulmonary tuberculosis at ages 60 and over reaches truly appalling proportions, so much so that the statistical evidence would seem incredible if it were not supported by the additional and equally suggestive data for non-tuberculous respiratory diseases.

6. The investigation brings out clearly the supremely important fact that the incidence of the disease is practically proportionate to the length of the trade life. In other words, the effect of dust inhalation is one of growing seriousness, according to the rate of dust accumulation in the lungs.

These conclusions are in conformity to the observations made in South Africa and Australia, clearly indicating that the cause of the excessive liability to pulmonary tuberculosis is the inhalation of granite dust in a comminuted form of practically ultramicroscopical particles.

7. The nature of the dust inhaled also requires much more extended scientific consideration. For the present purpose, however, it is sufficient to state that the average silicotic content of granite is 72.96 per cent.; of sandstone, 85.42 per cent.; and of limestone, 1.22 per cent.

The evidence is absolutely conclusive that the dust hazard depends primarily upon the silicotic content of the dust inhaled. The evidence is also conclusive that workers exposed to marble or limestone dust suffer a decidedly lesser liability to pulmonary tuberculosis than those exposed to granite or sandstone dust, with a high silicotic content. For the present purpose it may be sufficient to say that radiological examinations have been of the utmost value in determining the progress of dust infiltration throughout the lungs and in clearly indicating the extent of stone consolidation to the point of fatality. If the so-called pulmonary tuberculosis among granite-stone cutters is not a true tuberculosis and therefore not infectious, some evidence should be forthcoming from the family records of deceased stone workers to substantiate this point of view.

8. The present investigation includes the question of previous occupation and many related aspects which do not admit of a brief generalization, such as hours of work,

dust removal, and length of vacation.

At the present time the death rate among granite workers is practically the highest known for any occupation on record, and the increase in the death rate from year to year is lamentable evidence of inefficiency on the part of health-promoting agencies to bring about reduction and control.—M. C. Shorley.

A Conception of the Chest Roentgen-Ray Densities Based on a Study of Granite Dust Inhalation. *D. C. Jarvis.* Abstracted as follows from Am. Jour. Roentgenol., April, 1922, 9, No. 4, 226, in Am. Rev. Tuberc., Sept., 1922, 6, No. 7, 192-193. —Roentgenographic studies proved that, given the same number of years of exposure to granite dust inhalation a cutter with the minimum amount of lymphoid tissue in the upper respiratory tract showed a minimum number of densities on the roentgenogram, while a cutter giving evidence of considerable lymphoid tissue in the upper respiratory tract showed in proportion many densities upon the film. It seems, therefore, that the lung and pleural lymphatics are brought into prominence in this condition. Serial roentgenograms disclosed the fact that it was possible, in order of their sequence, to divide the development of the densities upon the chest roentgenograms into six stages, as follows: *Stage I, that of the hilum:* If the hilum retains its crescentic form, without central enlargement, it is to be assumed that exogenous chemical or bacterial invasion has been near the minimum. If there are central enlargement and an increase in extent and density of the hilum, it is concluded that the patient has been in an unfavorable respiratory environment, inhaling bacterial or chemical irritants in large amounts for a short period or in small amounts for a long period. The periphery of the hilum may show what region of the lung has been most affected and hilum changes follow fairly closely the lung changes, clearing away when dust inhalation stops and reappearing when it is resumed. When certain pleural densities appear, the hilum changes regress; this is possibly explained by a disappearance of the lymph stasis when drainage from the periphery is cut off. Just external to the hilum and accompanying progressive change in the latter, circular densities develop; they disappear when absence from work occurs and reappear when granite dust is again inhaled. These have usually been considered diseased lymph nodes, but it is concluded that they are really valves in the pleural lymphatics which arrest the irritating material coming from the lung periphery, until the accumulation in the hilum can be moved on. *Stage II, that of linear densities:* This is separated into three divisions. The first division consists of the broad densities in the hilum zone, most noticeable in the descending trunks. These widened linear shadows come and go in granite cutters and seem to be caused by lymph stasis. The second division consists of linear densities appearing mostly in the midzone of the lung field; they represent septa existing between the lobules of the lung. The third division consists of a network of thread-like markings in the peripheral zone and a portion of the midzone of the lung; they are the last phase of the linear markings to appear and are the forerunner of "thickened pleura." They coincide with the polyhedral pleural rings and overlie the interlobular septa markings. *Stage III, that of circular densities, and stage IV, that of Dunham's fans:* Circular densities appear at the junction and also on the polyhedral rings. At first a fan-shaped area is outlined by the interlobar septa; then a circular density appears at the apex of this area, the size of the density depending on the behavior of densities peripheral to it when they occur. Fine linear markings then appear within the fan-shaped area and circular densities appear upon the interlobular septa acting as sides of the fan-shaped area. Circular densities develop upon the linear markings within this area and finally it is obscured by a diffuse cloudiness. The circular areas are on the course of lymphatics that are choked with dust and developed only as the process progressed. *Stage V, that of the peripheral haze:* This appears at the lung periphery following the development of all the linear markings and it is a forerunner of "pleural thickening." It extends from the clavicle downward. *Stage VI, that of the pleural lymph stasis:* This is represented by a thick haze, developing over the lung, and depends on the extent of lymph stasis

in the pleura. X-ray studies indicate that we do not have only one infection by the tubercle bacillus and this occurring in childhood, but that we have innumerable infections all through life, and that the occurrence of a lesion depends in part upon the efficiency of the lymphatics which act as the first line of defense in event of an irritant, either mechanical, bacterial or chemical, entering the lungs by way of inhalation. At least twice a year a worker in a dusty trade, of which there are 200 in this country, should have an X-ray chest examination to determine the likelihood of subsequent respiratory disease.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Some Industrial Phases of Tuberculosis. *Frank A. Craig.* Nation's Health, Aug. 15, 1922, 4, No. 8, 491-494.—There is no more important part of the problem of tuberculosis that that which deals with the relationship between this disease and the industrial worker and his environment. The industrial group is highly important, and it is exposed to certain risks and factors peculiar to factory life and not reached by any measures directed toward the prevention of the disease in the general public.

The foremost need is for reliable information concerning the incidence of tuberculosis in industries, and in the occupations involved in them. Reports published are now lacking in uniformity and are so variable as to standards regarding defects that they are of little value for statistical purposes.

Some general principles may be applied to the problem of tuberculosis as it affects the industrial worker. A vigorous educational campaign is the first requirement. There must also be early detection of the disease—the preservation of the working capacity of the individual is almost absolutely dependent upon it. This fact is shown by the chart recently published by the Prudential Insurance Company of America based on a study of 65,000 cases, showing the results of treatment in sanatoria in cases with varying degrees of involvement.

The entrance examination is not sufficient, but should be combined with periodic health examinations of the entire working force at intervals that cannot be declared at present, though it seems as if examinations would be most effective in any general plant if conducted annually.

The rejection of the unfit and of dangerous cases is by no means the most important function of the entrance examination. Many men will be found who are below normal, possibly suffering from defects that cannot be corrected but that will not seriously interfere with working capacity if the men are suitably placed. Among such are cases with signs of slight contraction or fibroid change at one apex, or both, of the lungs. Selection of work for these men requires the greatest care and judgment on the part of the examiner. Probably the large majority of these men may perform work of a proper kind under suitable conditions with perfect safety, but they should not be assigned to any position that would expose them to dust, dampness, poor ventilation, or great variation in temperature; and they should not be allowed to do heavy manual labor. Competence in making diagnosis is highly important in this work, but, contrary to the general belief, this does not necessarily mean that every examining physician should be what is generally termed a tuberculosis expert. More cases of tuberculosis remain unrecognized because of lack of care and thoroughness in the examination than are missed because of ignorance or inexperience.—G. E. Partridge.

Gonorrhea and Syphilis in Industry. *William F. Snow.* Nation's Health, Aug. 15, 1922, 4, No. 8, 495-496.—Before the war the American health officer almost entirely ignored venereal diseases, but today there exists a reasonable practical organized defence against them. In this work there are four major activities: education; law enforcement, medical measures; and recreational facilities.

Both gonorrhea and syphilis are important from the standpoint of the industrial employer. They involve loss of time, morbidity, worry on the part of workers; their com-

municability, too, is a consideration. The result is undoubtedly felt in plant costs and production rates. Reduced production may result from muscular inco-ordination during early stages of tabes, ocular manifestations of syphilis, bladder trouble, early cardiovascular symptoms, bone and nerve involvement Latent syphilitic infection may play an important part in the immediate and late consequences of trauma, while from the late disabling manifestations of syphilis the employer sustains the greatest losses of all.

It has been shown that if a syphilitic workman sustains, under certain circumstances, an injury which causes an aneurism or paresis or any of the possible results of traumatizing syphilized tissue, he is entitled to compensation provided it can be proved that injury arose in the course of and through employment. The preexistence of syphilis does not lighten the responsibility of the employer. There is hardly a phase of plant management, therefore, that may not be affected by the presence of unrecognized or uncared for venereal disease.

The means open to the employer for controlling this loss are early recognition of cases and careful and thorough diagnosis and conscientious treatment. It seems feasible to approach the problem through the physical examination for employment or through the periodic examination, but the routine examination for the recognition of syphilis, etc., does not seem practicable. Greater special observation in the regular observation may be resorted to. The medical department of an industrial organization should not necessarily provide for the diagnosis and treatment of venereal diseases, unless there are no other facilities available. Industry is, however, reasonably interested in the betterment of community medical service, and for industrial organizations that largely make up the community it may even be profitable to finance entirely the community's attack on gonorrhea and syphilis.—G. E. Partridge.

Human Anthrax and Arsphenamin. *A. H. Louw* and *A. Pijper*. Abstracted from So. African Med. Rec., July 22, 1922, 20, No. 14, 273, in Jour. Am. Med. Assn., Sept. 16, 1922, 79, No. 12, 999.—The treatment of human anthrax by means of intravenous injections of arsphenamine or its substitutes has been employed by Louw and Pijper in eleven cases. All the patients made a very speedy recovery.—K. R. Drinker.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Formaldehyde Eczema from Paste. *Chajes*. Zentralbl. f. Gewerbehyg., May, 1922, 10, No. 5, 136-138.—Thirteen workers in a papier-mâché plant, who handled paste all day, suffered from acute and beginning chronic eczema on the hands and arms. This yielded readily to treatment when the paste was changed so that formaldehyde was no longer used to preserve the starch in the paste. Excess sodium chloride was substituted and the men returned to work without trouble. The formaldehyde was less than 0.5 per cent. in the fresh paste used.

Industrial Ophthalmology. A Survey of Twenty-Five Thousand Cases. *V. E. Van Kirk*. Jour. Am. Med. Assn., Sept. 16, 1922, 79, No. 12, 951-954.—The series of cases upon which this survey is based comes from a steel mill employing about 8,000 men. Severe injuries to the eyes have been greatly reduced during the past twelve years by educating the employees, and by the compulsory use of goggles and other safety devices. By far the greater number of the cases are minor injuries, the majority from foreign bodies. All eye cases are seen by the company ophthalmologist who visits the first-aid station at a definite time every day. When a foreign body cannot be removed with a cotton swab by the physician or nurse on duty, the patient is made comfortable by instillation of phenacain or butyn solution, mercuric chloride ointment and a patch. The patient is then allowed to return to work until the next visit of the ophthalmologist, when the foreign body is removed and the necessary treatment instituted. Careful follow-up work is an important factor in eliminating the occurrence of corneal ulcers, and

in reducing to a minimum the amount of lost time.

The author next refers briefly to the occurrence of intra-ocular foreign bodies and of eye burns, to the treatment of corneal opacities and of cases of exposure to electric flashes, and to the occurrence of trachoma among his workers.

The paper ends with the suggestion that the next step in industrial ophthalmology will be the refraction of all employees and the correction of defects—a procedure which will be more than paid for by the increased efficiency of the men.—K. R. Drinker.

Industrial Diseases of the Eye. *H. Dickinson.* Am. Jour. Ophth., Aug., 1922, 5, No. 8, 674-676.—At a recent Congress of the Ophthalmological Society of the United Kingdom, the following industrial diseases of the eye were discussed: Optic neuritis due to lead poisoning, accidents, miners' nystagmus and glass blowers' cataract, tobacco amblyopia, anthrax, visual fatigue and the relation of industrial work to myopia, visual acuity and vocational selection, visual acuity as related to accidents, tin-plate workers' cataract, cataract among iron workers, and posterior polar cataract as related to the work of gold smelters and assayers.—G. F. Partridge.

First Report of the Miners' Nystagmus Committee. Med. Research Council, Special Report Series No. 65, London, 1922, pp. 64.—The Miners' Nystagmus Committee which has been engaged in investigating the causation and means of prevention of miners' nystagmus, gives here a detailed report of its results.

A former view of the disease, namely, that it is a local myopathy of the elevator muscles of the eyes or the result of excessive accommodation, has been replaced by the view that it is either a general fatigue of the whole oculomotor system or a general neurosis with special local manifestations in the oculomotor apparatus.

The report includes a brief historical survey; a study of the incidence of the disease with reference to economic factors, seasonal prevalence, etc.; a description of the disease, its symptoms, physical signs, and course; etiological factors; diagnosis; prognosis; and treatment. There is a reference list of seventy-one items, many maps, photographs, and diagrams, and an appendix by Dr. W. H. R. Rivers on psychoneurotic symptoms associated with miners' nystagmus.

The committee unanimously reached the conclusion that the essential factor in miners' nystagmus is deficient illumination. Other factors, such as position, accidents, alcoholism, infections, malnutrition, hereditary predisposition and errors of refraction are of secondary importance, while depth of working places, thickness of seams, and the ordinary gaseous impurities in mine air have no direct influence upon it. The deficient illumination is due to the low illuminating power of the safety lamps in general use, to the distance at which the lamps must be placed from the work and the great absorption of light by the coal and coal-dust covered surfaces. Workers at the coal face are more affected than underground workers.

The main remedy is to make all possible effort to have the standard of illumination of the objects looked at by the miner equal to that of an open-light pit. This can be done by greatly increasing the power of safety lamps, or by the use of an electric light capable of being fixed on a miner's head belt or other convenient place, and by whitewashing parts of the pit other than the coal face. To prevent the occurrence of psychoneurotic symptoms, the erroneous belief that the disease causes permanent damage to sight and even total blindness should be dispelled. The investigation of various localities led to the conclusion that the great variations in incidence cannot be explained unless the influence of the attention paid to the disease is taken into account. Comment is made on the fact that in consequence of scheduling miners' nystagmus in the Workmen's Compensation Act of 1906 the incidence of the disease has been greatly increased, solely through action on the psychical and psychoneurotic aspects of the disorder.—G. E. Partridge.

Eye Symptomatology in Occupational Diseases. *Donald J. Lyle* and *Carey P. McCord.* Nation's Health, Oct. 15, 1922, 4, No. 10, 613-615.—The purpose of this paper is to describe a number of occupational affec-

tions of the eye that do not present the ordinary characteristics of the swiftly produced injury; that may develop slowly and insidiously, and therefore are not associated either by the worker or the physician with the occupation which may be the producing cause. Occupational affections of the eye are discussed under the following heads: occupational affections, nystagmus, carbon-monoxide poisoning, ocular lead poisoning, methyl alcohol, aniline, and occupational cataracts.

The Localization and Extraction of Intra-Ocular Foreign Bodies. *James M. Patton.* Jour. Am. Med. Assn., Sept. 23, 1922, 79, No. 13, 1030-1034.—The points which the author of this paper stresses are as follows:

In any case of a penetrating wound of the eye, the absence of a foreign body must be proved.

If the roentgenologist cannot localize accurately, co-operate with him experimentally until he can.

Discuss the prognosis with the patient or a responsible relative before beginning the operation.

Choose the route in accordance with the needs of the individual case.

Do not give up too easily. Success is frequently the result of repeated efforts.

Radiography of Foreign Bodies in the Eye. Am. Jour. Ophth., Aug., 1922, 5, No. 8, 677-678.—The foreign bodies that are usually sought in the eye are generally situated in the anterior part. Most of the work that has been done in locating such bodies has been on the assumption that the examination must be made with tubes and exposures that will cause the rays to penetrate even thick bony masses, whereas if a radiogram can be obtained showing the soft parts as the lids, lashes, profile of the cornea, etc., the foreign body will give a more distinct shadow on it, and be better located. The difficulty in making the desired short time exposure is in placing the tube or film where it can receive the rays that have passed through the eyeball without going through bony structures. Recently Vogt has described a method of thrusting the sensitized film, properly wrapped, into the conjunctival sac adjoining the nose, or in the lower culdesac, placing the tube so that the rays will pass just anterior to the outer or upper margin of the orbit; thus obtaining negatives of great distinctness and delicacy, showing the anterior segment of the eyeball and any foreign body that it contains.—G. E. Partridge.

Selecting Proper Goggles for the Job. *E. S. Chapin.* Nat. Safety News, Sept., 1922, 6, No. 3, 39, 44.—The best information on the subject of proper selection of goggles is contained in the National Safety Code for the Protection of the Heads and Eyes of Industrial Workers, Handbook No. 2, issued by the Bureau of Standards in Washington. In it industrial processes are grouped according to the nature of the hazard, while the type of goggles best for each is recommended. In general, when selecting goggles it is well to observe differences among the samples that conform to the code and to give preference to that type which will be most comfortable to the wearer. Results of tests should be tabulated and distributed to storekeepers, shop managers, and others responsible for the ordering and use of goggles. Particular attention should be paid to workmen requiring corrective lenses; in these cases frames should be of the rigid bridge type.

Several lines of improvement may be suggested: that the weight of goggles be decreased without sacrificing strength; that materials used be less liable to break or deteriorate; that, on unpadded frames, surfaces bearing against the face be made broad, smooth, and correct in form.

Speeding up Work with White Typewriters. Abstracted from Eye-Sight Conservation Council of America, 1922, in Factory, Sept., 1922, 29, No. 3, 312, 314.—Unnecessary fatigue is produced by looking at objects of different color and of different brightness, such as white paper and a black typewriter. This fatigue is due to the fact that the pupil of the eye is constantly trying to adapt itself to that part of the retina of the eye which is under-stimulated or overstimulated by black and white objects viewed simultaneously.

The white typewriter has been shown to secure extremely high speed with the least fa-

tigue resulting. Consequently, any worker who works continuously on a black and white object will have the pupils of his eyes continuously contracting and expanding alternately with an ever-increasing periodicity until excessive eye fatigue sets in.

Determination of Disability as to Loss of Hearing, and the Importance of Vertigo in Industrial Accident Cases. *Harold A. Fletcher.* Jour. Am. Med. Assn., Aug. 12, 1922, 79, No. 7, 529-531.—The following conclusions by the author sum up the contents of this paper:

1. More thorough examination, deeper thought and more careful analysis of industrial injuries involving the ears, and more comprehensive reports to the insurance companies should be the physician's endeavor.
2. It is believed that the hearing can be more fairly estimated by a system of weights proportionate to the value of the tests for hearing.
3. The neurotologic examination should be made of all patients with head injuries complaining of vertigo, as the findings in these examinations may be the only evidence by which the neurologist can differentiate the traumatic neurosis from those cases in which there are central organic disturbances.
4. These patients should be reexamined over a period of years, if possible, to determine the relation of the duration of the symptoms to the duration of his abnormal reactions.—K. R. Drinker.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Industrial Accidents and Their Prevention. *A. Wiese Hammer.* Nation's Health. Aug. 15, 1922, 4, No. 8, 497-499.—This is a general article emphasizing the great excess of industrial accidents in the United States over those in other countries, and outlining the legal situation and the ideal status of compensation that would be attained if the public, the employer, and the employee each assumed an equal share of responsibility, and if the present unassigned burdens were distributed properly.—G. E. Partridge.

Up-to-date Protection for Punch Presses. *C. B. Auel.* Nat. Safety News, Sept., 1922, 6, No. 3, 33-34.—The worker on continuous or repetitive work is usually readily protected, but when a general purpose press has to be adapted to a variety of work the problem is more complicated. When left-over material is used on new work, the problem is still more difficult. The most positive guard for this kind of work is perhaps one which encloses the ram, leaving just sufficient space, not exceeding three-eighths of an inch, for the insertion and removal of the material. Many jobs do not admit of a positive guard, however, and resort must be made to other forms such as hand tools, etc., for handling materials and sweep guards which push or pull the hands out of danger. A further safeguard is a non-repeat treadle attachment which prevents a second stroke of the press until the treadle is again depressed.

Safe Clothing for Industrial Workers. *G. E. Sanford.* Nat. Safety News, Sept., 1922, 6, No. 3, 32.—While accidents caused by improper clothing are comparatively few in number, they are usually severe. They are most common in the fall of the year, when, on account of the cold, workmen begin to turn down their sleeves. The time, therefore, for the safety engineer to make a special drive against the loose sleeve hazard is just before the autumn frosts are expected. The use of gloves, also, is a danger that must be controlled. Many industrial occupations require gloves, but the man who habitually uses gloves unnecessarily is a dangerous man in the shop. Linen dusters and long aprons have caused serious accidents, and loose hair is a menace. Women should be encouraged to wear caps, hair nets, or, in warm weather, bands of white voile across the forehead. Men who wear the hair long in front should wear caps. Special clothing is required in such occupations as foundry work, and the writer has been experimenting with shoes laced in the back which protect from metal splashes and also provide support for the ankles. For such operations as require the

use of gloves, hand covering should be provided that is suited to the special need.

Protecting the Electrical Worker with Safer Clothing. *H. J. Burton.* Nat. Safety News, Sept., 1922, 6, No. 3, 42.—There are many accident hazards due to improper clothing, some common to all industries, some peculiar to given trades. The electrical worker is exposed to both kinds.

If a man has metal on his person his clothing becomes to a greater extent a conductor of electricity. Dry cotton and wool are not good conductors, but clothing that is wet or damp is more or less a conductor. Circuits formed with dangling chains attached to metal buttons in contact with damp underwear have resulted sometimes in fatal shocks. The wire used to stiffen the rim of a hat may prove dangerous. Everything of this kind is unsafe, as are glasses with metal frames. Celluloid collars are bad. Nails in the shoes are a menace, although the shoe without nails, if damp, is also unsafe. The electrical worker should know that when standing on the ground or on a concrete floor he is "permanently and effectively grounded."

Conductors carrying primary voltages should not be touched with the bare hands, with ordinary gloves, or with metal tools or objects held in the bare hands. Dry clothing is slight but insufficient protection; standard rubber gloves, insulated tools, lineman's protectors, and rubber blankets to cover adjacent conductors are good. A sound rubber shoe or boot without nails gives good protection for the man who works around low voltage conductors. Goggles should be worn whenever there is danger of an electric arc or flash. The provision of a proper uniform, such as a one-piece suit having no loose ends, tends to prevent accidents.—G. E. Partridge.

INDUSTRIAL SURGERY

The Foot Factor in the Future of Women. *Harriet Wilde.* Nation's Health, Sept. 15, 1922, 4, No. 9, 520-524.—Distorted feet may be caused either by the nature of the shoe which is worn, or by the manner in which one walks or stands. In this article the author discusses the normal versus the abnormal foot; the correct manner to stand and walk; the effect upon the foot of various types of shoes, etc., with special reference to women.—L. A. Shaw.

A Method for Maintaining Pressure over Elbow in Olecranon Bursitis (Miner's Elbow), without Immobilizing the Joint. *Guy S. Van Alstine.* Jour. Am. Med. Assn., Aug. 12, 1922, 79, No. 7, 557.—The author describes a bandage, cut from an automobile inner tube, which he uses in cases of recent olecranon bursitis to maintain pressure on the bursal sac without greatly inhibiting the joint action. With this device patients are able to continue their usual occupations while under treatment.—K. R. Drinker.

Treatment of Industrial Accidents to the Knee-Joint. *R. Wallace Billington.* Jour. Am. Med. Assn., Oct. 7, 1922, 79, No. 15, 1207-1209.—Injuries to the knee resulting from industrial accidents comprise practically all types of traumatic lesions, except gunshot wounds, and these have their counterpart in the penetrating and lacerating wounds not infrequently encountered. Knowledge of special points in the diagnosis and treatment of knee injuries is essential if these patients are to be back at work in the shortest possible time and with the least disability.

Among the more common types of knee injuries encountered are simple traumatic synovitis, subacute or chronic synovitis, injuries to the semilunar cartilages, rupture of the internal lateral ligament and of the crucial ligaments, fracture of the tibial spine or its inner tubercle, Osgood-Schlatter disease, dislocations of the patella, fractures of the femur and tibia which enter into the knee joint, and open wound into the joint cavity. The author discusses practical points in the proper treatment of these various conditions.—K. R. Drinker.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

The Efficiency of Man. *E. P. Cathcart.* Lancet, Sept. 9, 1922, 203, No. 5167, 547-551. —There are two types of human efficiency: mechanical efficiency in the engineering sense, and industrial or productive efficiency. Both are closely related and both are physiological problems. New inventions may revolutionize shop equipment, but, so long as machines need men, physiological laws must be a factor in industrialism. The unhygienic conditions produced by the industrial revolution exposed the national stock to a strain which manifested itself in the high yield of C3 lads recorded in the National Service Report; while the latest Health Insurance figures give the minimum average amount of sickness per annum as 14,476,074 weeks, or upwards of 278,000 years.

The human organism is not at fault; it has a whole series of protective mechanisms at its command, and, so long as it remains physiological, it is practically unaffected by ordinary hard work. Fatigue is the main protective mechanism of both mechanical and industrial efficiency. Fatigue—a diminished capacity for doing work—cannot be determined by any known quantitative test; certainly study of metabolism gives little or no clue, for a person may be on the verge of absolute collapse with no marked evidence of diminished efficiency in a mechanical sense.

Four factors contribute to maximum efficiency—speed, rest, rhythm, and work habits. With regard to speed, so long as it is subject to the capacities of the human agent, and is not the driver of those capacities, it counts as gain; this observation of field workers is substantiated by laboratory experiments in which an optimum speed for muscular contraction was found; speeds above or below gave less efficiency. Speed is directly associated with load; there is an economic optimum with high efficiency and a low oxygen consumption per kilogrammeter, and a mechanical optimum when output in unit of time is highest; the two do not coincide. When load becomes excessive, efficiency rapidly falls away, because static expenditure in muscular effort, which is parasitic on dynamic work, becomes dominant. Rest allows removal of waste products and a more abundant supply of oxygen; there is a tendency to find spontaneously the optimum rate of work where intervals of repose suffice for recuperation; still little attention has been directed to planning rest-periods in relation to work in progress. Rhythm is a fundamental property of the nervous system, and the capacity of the organism to build up a series of rhythmic reflexes is a potent factor in preventing fatigue; workers naturally adopt rhythmic movements, although not always the most efficient. Nutrition is another factor, since food inadequate in quantity or quality lowers actual performance and resistance to disease; of this Germany during the war provided a gigantic experiment. Monotony and atmospheric conditions also play their part. Efficiency is complex and needs for its investigation co-operation between the research worker, the employer, and the employee.—E. L. Collis.

Motor Capacity with Special Reference to Vocational Guidance. *B. Muscio.* Brit. Jour. Psychol., 1922, 13, pp. 157-184.—Many mental tests, the specifically "intelligence" tests, show a high positive correlation, and this is an important fact in vocational guidance. Very few investigations have hitherto been made to determine the correlation between motor tests, with a view to finding out if a general motor capacity exists. Tests were made on a group of 20 boys, aged about 15; groups of 16 and 20 girls, aged 13; a group of 20 women medical students; and one of 12 Cambridge undergraduates, 6 men and 6 women. The tests employed consisted of (*a*) tapping at the greatest possible rate; (*b*) drawing a pencil point between two lines 2 mm. apart; (*c*) time taken to fit blocks into the holes of a form board; (*d*) time taken to put matches back into a match box; (*e*) capacity to hold a thin metal rod inside a small circular hole without allowing it to touch the circumference; (*f*) an aiming test (Whipple); (*g*) a total strength test (Martin), and one or two other tests. All the

tests were not, however, used for each group of subjects.

The correlation coefficients observed were usually very small and were often negative. In one group the highest coefficient observed was 0.40, and in another group, 0.50. In one group alone (the undergraduates) there was moderate correlation, the highest coefficient observed being 0.56, while more than half the coefficients exceeded 0.36. As far as the tests go, they show little or no increase of intercorrelation as the result of practice, and they agree in this respect with Hollingsworth's observations on motor tests. His mental tests, on the other hand, showed that practice increases the intercorrelations to a marked degree. The author comes to the conclusion that terms such as "motor dexterity" or "practical ability" are misleading, as a person's relative performance in any one motor test does not represent what will be performed in any other motor test.

Hence it follows that, from the point of view of vocational guidance, every occupation which consists mainly of a routine performance of specific movements will require specific vocational tests of just those motor capacities that function in that occupation. Motor capacities are relatively independent of intelligence, for since motor tests do not correlate positively with one another to any appreciable degree, they cannot in general correlate positively with any other tests, and therefore not with intelligence tests.—H. M. Vernon.

Apparatus for Estimating the Working Capacity of an Upper Extremity. *J. Glaister, Jr.* Brit. Med. Jour., Aug. 26, 1922, 2, No. 3217, 380-381.—This apparatus consists of a box 36 inches long, 12 inches broad, and 20 inches deep, with a series of six holes in the upper surface, through each of which projects a steel bar fitted with a handle on the outside and a hook on the inside; to the inside hooks are attached weights in a graduated series. The advantages appear to be (1) that the patient cannot see the weights which he is asked to lift; (2) that the order and the amount of any weight can be altered at the will of the examiner; (3) that it is a help in the detection of malingering; and (4) that, as the rods are each 1 foot in length, the working capacity can be assessed in foot-pounds.—W. F. Dearden.

Lessened Ability to Distinguish Colors as a Sign of Fatigue. Jour. Am. Med. Assn., Sept. 9, 1922, 79, No. 11, 909.—As the result of examination of athletes following various forms of physical exertion, it has been shown that as the body becomes fatigued the ability to distinguish colors becomes much diminished. According to Boehmig, who has an article on the subject in the *Münchener medizinische Wochenschrift*, certain subjects who, when examined immediately before the physical performance, were found to possess a perfectly normal ability to distinguish colors, were unable, after the body became fatigued, to recognize the color of very small green and red objects, and some presented transient scotomas, which, however, were of a mild sort, so that the subjects were frequently not aware of their existence. In the case of the heavy smokers and those addicted to alcohol, the manifestations appeared in a more marked form. The so-called fatigue substances will doubtless have to be assumed to be the cause of this hitherto unobserved disturbance of color vision.

HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

Regarding Death from Electric Current. *Karl Meixner.* Wien. klin. Wchnschr., 1922, 35, No. 28, 619-623.—The postmortem findings in four cases of accidental death are described. The very striking fact is observed that these cases showed lesions of early heart disease such as are seen in young adults who have died suddenly from natural causes. It is a question, therefore, whether a sudden attack of weakness caused the shock to be fatal, or whether the opposite occurred. Aside from local burns, no other lesions were observed that were referable to exposure to the electrical current.—B. Cohen.

Pathologic Changes Produced in Those Rendered Insensible by Electric Shock and Treatment of Such Cases. *J. A. MacWilliam.* Abstracted from Arch. Radiol. and Elec., June, 1922, 27, No. 1, 11, in Jour. Am. Med. Assn., Oct. 14, 1922, 79, No. 16, 1364.—By experimental investigation MacWilliam has found that there are two modes of immediate death by electric shock, and there may be a combination of the two. In the ventricular fibrillation due to electric shock, artificial respiration should be at once begun to keep open the possibility of recovery of the ventricular beat which may possibly occur, though if the period of ventricular fibrillation is more than a very brief one the central nervous system will probably have suffered irretrievable damage from the period of circulatory arrest. The only active remedial measure that has been found useful in ventricular fibrillation so far, that is, massage of the heart through the diaphragm after the abdomen has been opened, is obviously not available under the conditions in which electric shock occurs. Heart massage, when applicable, is rendered much more effective by the intracardiac injection into left ventricle or a vein of urethane, from 0.025 to 0.25 gm.; strontium chloride, from 0.01 to 0.06 gm.; epinephrine, from 0.1 to 1 mg.; herudin, from 8 to 10 mg.; pilocarpine (injected into vein), 0.0025 gm.

WOMEN AND CHILDREN IN INDUSTRY

Care of Older Women Employees by Boston Retail Stores. *Sarah L. Proctor.* Abstracted from Women's Educational & Indust. Union, Boston, Studies in Economic Relations of Women, 1921, 11, 103-108, in Digest, May-June, 1922, 4, Nos. 5-6, 18.—In eighteen large and long established retail dry goods and clothing stores in Boston, only 9.9 per cent. of the 4,190 women for whom data were available, had been with the firm for ten or more consecutive years at the time of the inquiry. Many women had made changes in employment after from twelve to twenty-six years of service with one firm. Six of the stores aided their retired women with gifts of money when trying situations arose. Five firms shifted older women to lighter jobs and others permitted them to come later and leave earlier.

Only one firm had a definite pension system in use. Under this, employees earning $20 or less received pensions figured on 3 per cent. of the average annual salary for the past ten years, multiplied by the number of service years. If the salary exceeded $20 weekly, the yearly pension was figured on 2 per cent. of the average annual salary.

Child Labor Prohibitions for Industrial Home Work. Am. Child, Aug., 1922, 4, No. 2, 78.—The following regulations governing industrial home work, submitted for a final public hearing at Philadelphia on May 4, 1922, were adopted by the Industrial Board, May 9, 1922, to become effective September 1, 1922:

1. Minors under 14 shall not be employed in industrial home work.
2. No minor under 16 may be employed for more than fifty-one hours a week, nor more than nine hours a day, nor before 6 o'clock in the morning nor after 8 o'clock in the evening.
3. Every minor between 14 and 16 years of age must attend, for the equivalent of not less than eight hours each week, a continuation school in the school district where said minor is employed.
4. These eight hours shall be reckoned in the fifty-one hours a week permitted above.
5. Minors between 14 and 16 shall not work without an employment certificate, which certificate must be kept on file by the employer.
6. General employment certificates are required where children under 16 are employed all the time.
7. Vocation employment certificates are required where minors under 16 work at any time except when they are required to attend school.
8. Employment certificates may be issued only by the District Superintendent, Supervising Principal, or Secretary of the Board of School Directors, or other school official, deputized in writing by any of the other school officials authorized by law to issue such certificates.
9. No minor under 16, who has not completed the work of the sixth grade in public schools, shall be entitled to an employment certificate.
10. Before an employment certificate be issued, the prospective employer must make a statement in writing that he expects to give employment to a minor applying for such certificate.
11. Employers must acknowledge, in writing, to the issuing officer, receipt of an employment certificate within three days after beginning of minor's employment.
12. Upon termination of employment, the employer must return the employment certificate to the issuing school official.

The Working Children of Boston. A Study of Child Labor under a Modern System of Legal Regulation. *Helen Sumner Woodbury.* U. S. Dept. Labor, Children's Bur. Pub., No. 89, 1922, pp. 374.—This study was undertaken for the purpose of ascertaining the amount, character, conditions, and effects of employment of children under 16 years of age in an American city of diversified industries and a considerable volume of trade, and in a state having comparatively advanced child labor legislation. Information in regard to these child workers was obtained chiefly from:

1. The employment-certificate records of Boston, Cambridge, Somerville and Chelsea.
2. The Boston continuation-school records.
3. Schedules taken in interviews by agents of the bureau with a group of children attending the Boston continuation school.
4. Replies to a questionnaire sent out in December, 1918, to the children who had been interviewed.

In addition a special study was made of the child labor laws of Massachusetts and of their administration in Boston and its neighboring cities. For the findings of this study the reader is referred to the original report.—M. C. Shorley.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Oil Camp Sanitation in the Southwest. *C. P. Bowie.* Nation's Health, April 15, 1922, 4, No. 4, 222-225.—A deplorable lack of sanitation exists in many of the oil camps of Texas, Oklahoma, Louisiana, and Kansas. These mushroom communities, aptly termed "ragtowns," often have no water supply or a wholly inadequate one; garbage, rags, refuse of all sorts, are strewn promiscuously about. Privies are largely make-shift affairs with no pretense of screening from flies or protection from vermin. Insanitary conditions such as these result frequently in costly fires and epidemics, typhoid, dysentery, diarrhea, and in a loss of working efficiency among the men, which is often as high as 25 per cent. Statistics show that the time saved from illness by good sanitary measures far exceeds the expenditure for sanitation.

The three main factors in good camp sanitation are the building of the camp on high, dry land, with proper drainage; the provision of a safe water supply, and the installation of an adequate sewage and waste disposal system. The author especially recommends the septic-tank method of sewage disposal as suitable for camps of the type under discussion.—K. R. Drinker.

Need of Adequate Artificial Illumination. *G. Bertram Regar.* Nation's Health, Sept. 15, 1922, 4, No. 9, 550-553.—Manufacturers are beginning to realize that adequate lighting is a substantial aid to production, not only because it is conducive to increased efficiency, but also because 18 per cent. of industrial accidents are due to defects in lighting installations. Having secured a lighting system which meets with the requirements of health, safety, and efficiency, the question of maintenance, especially with reference to windows and painting of walls, is of the utmost importance. A well-lighted factory also exerts a profound psychological effect upon the workers, serving to reduce discontent and provide happiness.—L. A. Shaw.

Manufactured Weather and Personal Efficiency. *Willis H. Carrier.* Chem. and Metall. Engin., Aug. 30, 1922, 27, No. 9, 449-452.—This is a general discussion of the subject.—Philip Drinker.

Ventilation Fundamentals — Where Does the Society Stand? *E. V. Hill.* Jour. Am. Soc. Heating and Ventilating Eng., Sept., 1922, 28, No. 6, 605-617.—The author presents a brief discussion of methods in vogue for determining ventilation efficiency, followed by a plea for a standard practice among engineers and physicians. Examples are given of the use of the synthetic air chart which the author urges be employed as a basis of standardizing ventilation efficiency. —Philip Drinker.

Industrial Ventilation as Applied to Dust and Fume Removal. *H. M. Nichols* and *F. R. Ellis*.—At a meeting of the National Safety Council in Detroit, on August 30, 1922, this article was presented, in which are pointed out the possibilities of avoiding fume and dust nuisances by the adequate installation of fans, ducts, etc., in order to remove the fume and dust at its source. The frequent advantages of humidification which succeeds in removing dust nuisances, and particularly explosion hazards, are pointed out.

Common Sense in Factory Ventilation. *C.-E. A. Winslow*. Nation's Health, June 15, 1922, 4, No. 6, 359-360.—It is now universally recognized that the primary aim of air conditioning is to avoid overheating, and to provide a moderate degree of air movement. The causes of discomfort in the ordinary badly ventilated room are heat and stagnation combined in many cases with high humidity—and it is these conditions that must be controlled in the factory.

It has been shown that even a temperature of 75° F. exerts a profound influence upon body temperature, blood pressure, and heart rate; that it reduces efficiency, and tends to increase the prevalence of respiratory disease. Under conditions comparable to those of the factory the amount of physical work performed in a given time is 15 per cent. greater at 68° than at 75°. Statistics show that the temperature in factories is apt to be above the most favorable point, and that the loss in human vitality and productive efficiency due to overheating of the factories of the United States must be great.

The first step toward improvement is to understand the conditions. When the temperature is found to exceed 68° in the ordinary factory workroom something is wrong, and nine out of ten times the remedy is the application of common sense. An essential part of the duty of the foreman should be to place a thermometer in every workroom and make periodic observations. If the control of direct and indirect heating is not sufficient by itself to maintain a low temperature, window ventilation may be resorted to as the next step. If the room is large and crowded it may be necessary to adopt the three devices that have been found so useful in the ventilation of school rooms: the location of radiation units under the windows to temper the incoming air; the admission of air over slanting window boards to avoid drafts on those nearby, and the provision of a gravity exhaust duct for the removal of vitiated room air near the ceiling. In some cases, where conditions are especially difficult to control, a ventilating engineer needs to be consulted, and resort may be made to fan ventilating systems.—G. E. Partridge.

Simplifying Heating Systems. *R. J. Snell*. Factory, Sept., 1922, 29, No. 3, 260.—An account is presented of the effective heating and ventilating system in use at the shops of the Milwaukee Locomotive Manufacturing Company, whereby heated, fresh air enters by a system of overhead sheet-iron piping and is driven to all parts of the shop by two large fans. Heat is produced by a group of steam coils about 16 feet square and 12 feet in height. Air reaches these coils from two sources: through a lattice-work which may be opened or closed as needed, and through tunnels running beneath the plants. All air is returned still partially warmed, to be reheated and sent back over the plant.

The fans draw the air from each of these sources through the steam-heated coils and drive it through the large overhead sheet-iron pipes back into the plant. The sheet-iron pipe grows gradually smaller as each exit of air is reached, thus insuring an even flow of air throughout its length. Each exit for air is provided with a damper which may be operated by the workmen in the particular area being heated. One advantage of this system is that in summer, when fresh air is needed, the fans are so located that this air may be drawn in directly.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Health Service for Small Plants. *C. F. N. Schram*. Hosp. Management, Aug., 1922, 14, No. 2, 58-59.—Many employers of small numbers of workers would like to pro-

vide for their employees the best of medical and surgical service, but they cannot employ a full-time physician and they do not understand how to arrange part-time service.

A plan for the required service is outlined by Dr. Shipley under the following heads: (*a*) first aid and emergency measures; (*b*) preventive measures; (*c*) general administrative measures. The first comprises daily visits of the physician or nurse to the factory to attend to emergency cases; arrangements for the necessary hospital care; visits to homes; desired dental service. Under *b* are medical examinations for employment in order to discover and correct defects; periodic examinations to prevent disease; supervision of factory sanitation and hygiene; reduction of industrial health hazards by a study of materials and methods; inspections for the reduction of accidents; the study of methods of work; health education; investigation of home environment; proper recording of services given, with analysis and deductions. Administrative measures include: supervision of the field force of physicians, nurses and home workers; comparative study of data for use by industries; advice and testimony in law suits; following up procedures incidental to the workmen's compensation law; giving advice in respect to industrial health requirements and laws, with supervision of their application in the factories; current information about new laws, latest literature, etc.—G. E. Partridge.

Physical Examination of Postoffice Employees. Jour. Am. Med. Assn., Sept. 23, 1922, 79, No. 13, 1058.—At the request of the Postmaster General, boards of medical examiners from the United States Public Health Service in New York and Chicago examined postoffice employees to obtain a survey of health conditions existing in the Federal postoffices in those cities. Only those employees who volunteered were examined, a total of 985, from all the different occupations in the postoffice department. A thorough physical examination was made in each case, and the results were classified. In Class 1 (no physical defects) there were five employees; in Class 2 (minor defects requiring observation or attention) there were twelve; in Class 3 (moderate defects requiring hygienic correction or minor medical, surgical, or dental attention), 258; Class 4 (moderate defects requiring medical supervision as well as hygienic correction), 336; Class 5 (advanced physical impairments requiring systematic medical or surgical attention), 234; Class 6 (serious physical defects requiring immediate medical or surgical attention), 140. The results, compared with those obtained from garment workers, are given. The service is to be extended to all postoffice employees in the country.

Mercantile Hygiene in the Health Program. *A. B. Emmons.* Nation's Health, July 15, 1922, 4, No. 7, 431-433.—Twenty-five stores in six cities, combining two and a half years ago to study the health problems of the store, have now completed a sanitary survey. It has been found that there are defects in nearly all stores, in a sanitary way, but the writer concludes that sanitary conditions, with the possible exception of ventilation, do not form one of the major causes of the large amount of ill health found among workers in stores.

The physical condition of the employees in stores, in comparison with the standard set by college men and women, is in general, far below the average. Kellogg of Pittsburgh found that 95 to 99 per cent. of 1,200 workers in stores considered in groups according to age had from one to five defects—strongly contrasted with the 5 per cent. having defects found in an entering class at Harvard College and the School of Business Administration. The chief cause of this ill-health, the writer concludes, is lack of proper nutrition in the early years, and of training in habits conducive to health.

The most common affections are the common cold and the various diseases of nose and throat, which in their totality are very costly to store and employees. The next most common group consists of cases of malnutrition and indigestion, the problem of which is largely one of education. The group of functional nervous disorders presents an opportunity for intensive study; fear, worry, and anxiety are often found in an exaggerated form in this class of workers. The opportunity is good for studying the beginnings of diseases.

H. W. Stevens, in discussing this paper,

complains that physical examination in industrial groups has proved disappointing. The physical examination does not properly measure capacity, since it seems that it is not the defect alone that disables the worker but what he thinks about the disabling effect of his particular physical ailment. It is to be suspected that the larger part of the illness under discussion falls in the class of functional nervous disorders, and is not to be demonstrated by ordinary physical examination. Study of the statistics in regard to return to work after illness shows strongly the effects of ideas, since the physical condition can hardly be supposed to be subject to such variations as are shown in the figures.

Sickness Records in Preventive Work. *Edgar Sydenstricker.* Nation's Health, Aug. 15, 1922, 4, No. 8, 485-488.—Intelligent health administration in the industrial plant, as in the community, necessarily rests upon a knowledge of what ill-health exists in the plant and of the conditions under which it occurs. At present this information is too often neglected. The industrial medical officer is properly a sanitarian, but the vital statistics and disease records which constitute his epidemiological tools are of a special character. He has little use for mortality records and little need of the ordinary reports on communicable diseases; he is more concerned with indicators of health. Ailments and diseases that do not come to the attention of the municipal and state health officers are the principal objects for preventive work on the part of the industrial physician. To make this preventive work immediately effective, the incidence of symptomatic ailments and disease must be related to as specific conditions as possible.

Several general requirements for industrial health statistics and reports may be stated: (1) In any system of sickness records, provision must be made for expressing the incidence and prevalence of a symptom in terms of rates; every provision for classifying cases into nativity, sex, age, occupational or other groups should be accompanied by a similar provision for classifying all of the employees for whom case records are available. (2) There are certain basic items without which no analysis can be complete, such as items relating to individuals, with a basis of grouping them; items relating to the conditions under which the individual works and lives, items indicating physical condition and health. (3) There should be continued observation of the worker under various conditions, using the record of his deviation from good health as the measure of the influence of conditions after other factors have been taken into consideration. (4) The sickness record of an employee is a dependable measure of his health provided that illnesses of short duration are recorded. The shorter the illness which is recorded with a diagnosis, the more specific is the sickness record. (5) There should be simplicity in the recording and analysis of records. The fewer the facts and the more significant they are, the greater will be the return in knowledge. These methods are already in successful operation in some establishments.

Some practical suggestions in regard to details of record-keeping are offered, and there are two figures in the text, illustrating methods of co-ordinating data.

Dentist in Factory Saves Employees' Money and Time. Manufacturers' News, Sept. 28, 1922, 22, No. 13, 14.—A large eastern industrial establishment, which has recently installed dental equipment and a dentist in its factory hospital, has reported that a large percentage of its employees had diseased gums or defective teeth and that approximately all employees have availed themselves of dental treatment. It is estimated that the work, if done outside, would have cost the workers approximately $27,500.

About one-fourth of the operations were emergency cases. The lost time saved in the emergency work alone, the company estimates, would amount to about four hours a case. In other words, each emergency treatment, of which there were 6,010, represented a saving of four hours each to the man and to the company. This saving to the employee alone, figuring the average at 75 cents an hour, would amount to $18,030.00, making a total saving to the men of $45,530.00. Assuming that each hour lost was worth in production to the company 50 cents, the saving there amounted to $12,020.00.

Lost time due to sickness was also reported

to have been materially reduced by the dental treatments.—M. C. Shorley.

What Is a Good Plant Hospital? *J. A. Britton.* Nat. Safety News, Sept., 1922, 6, No. 3, 41.—The three units of a hospital are: (1) The surgical division, which should be equipped to take care of both major and minor surgical cases, and include equipment for work in eye, nose, and throat cases. There should be at least one or two beds for observation and emergency requirements, and it may be found necessary to provide baths for treating heat cases, since life depends upon giving treatment immediately. Most modern industrial hospitals should have a complete dental equipment, including a gas machine. (2) The second unit should provide for physical examinations and the care of medical cases, and for this a quiet examination room is the first essential. (3) The third unit is the laboratory, without which satisfactory work cannot be done. The minimum laboratory should provide for the examination of the blood, urine, and sputum, and for X-ray work (this is, however, dependent upon accessibility of other hospitals). All industrial establishments now have in addition to these facilities provision for taking care of sickness insurance cases and compensation cases, and these also require suitable offices. Another thing that must not be forgotten is the necessity for proper care of surgical and medical supplies and records. The location and surroundings of the plant hospital are of the utmost importance; it should be protected from ordinary shop noises and from dust, etc.

The plan of the emergency hospital at the McCormick Works of the International Harvester Company is shown.—G. E. Partridge.

INDUSTRIAL PERSONAL AND COMMUNITY HYGIENE: HOUSING, ETC.

Housing Conditions among Berlin Workmen. Jour. Am. Med. Assn., Sept. 2, 1922, 79, No. 10, 840.—The executive committee of the health insurance society of the city of Berlin has published a report, covering the years 1919 and 1920, on the housing conditions of its insured working-men. Among the interesting statements brought out by the report is the fact that the number of ill working-men living in houses and apartments fronting the street has decreased, while the number of those living in the cheaper rear dwellings and apartments has increased. In 1918 52.14 per cent. of ill employees were living in rear dwellings; in 1919 the number had increased to 53.46 per cent.; and in 1920 to 55.89 per cent. More than 5 per cent. of the patients were lodged in rooms with less than 10 square meters floor space. More than one-third were obliged to share their dwelling rooms with other persons. Even in rooms with only 6 square meters were found patients living with other persons. Approximately 5 per cent. of the patients lived in rooms, the ceilings of which were less than 2.5 meters high, the number of such patients having increased from 929 in 1919 to 1,494 in 1920. Of these dwellings, 39.96 per cent. were in cellars or basements, while 41.83 per cent. were in attics, which is especially significant in view of the fact that before the war the use of basements and attics was, for hygienic reasons, prohibited. In 1920, 13.46 per cent. of all patients were obliged to share their lodging with other persons. Twenty per cent. of these patients had some pulmonary affection.—K. R. Drinker.

INDUSTRIAL INVESTIGATIONS AND SURVEYS

An Investigation into Breakage Problems. *G. H. Miles* and *A. B. B. Eyre.* Jour. Nat. Inst. Indust. Psychol., Oct., 1922, 1, No. 4, 132-140.—Breakages of articles such as crockery are usually assigned to carelessness but this is far from being their true psychological cause. In some cases the worker was not aware of the slightest deviation in the method of handling the article. Sometimes she knew that the accident was about to occur, but felt powerless to prevent it. Conditions tending to induce irritation, excite-

ment or fluster, and those which distracted attention when breakable material was being handled, all tended to increase breakages. Hence the sources of irritation were investigated, and removed whenever possible. For instance, certain articles had to be brought quickly beneath a nozzle, filled, and passed on; by arranging a combined guard and guide, the process was rendered easier, and the clashing of the receptacle against the nozzle avoided. Some of the articles had to be placed in specially constructed racks or carriers. These were improved in form, and rendered easier of access, and workers were taught to combine in their sorting and stacking. The rush period of the day was provided for by the accumulation of sufficient stores, and the allocation of duties and routine. Thereby the flow of materials was smoothed out. Orders were transmitted by calls or a voice pipe, but the substitution of indicators, in which an appropriate button for a particular article had to be pressed, greatly reduced delays and consequent irritation. Workers were screened from undue heat, and the gas consumption in one department was reduced one-half.

The number of articles broken during the working day was investigated, and was found to amount to 2.2, 3.3, 2.2, and 5.7 per 1,000 articles handled during four successive two-hour periods. After introducing the reforms, it amounted to 1.7, 1.8, 1.9, and 1.6 for the respective periods, or to a reduction of 20 to 72 per cent. The workers themselves stated that the work proceeded much more smoothly and easily.—H. M. Vernon.

An Investigation in a Coal Mine (1). *E. Farmer, S. Adams,* and *A. Stephenson.* Jour. Nat. Inst. Indust. Psychol., Oct., 1922, 1, No. 4, 125-131.—Motion study observations were made on coal-getters, especially on the *rhythm* with which they used the pick. The best workers were found to use a comparatively slow stroke in getting coal, and a faster one in getting the harder "dirt" (substance in which the good coal is found). This higher rate for dirt was ascribed to the utilization of the rebound of the pick. Experienced but not very expert miners were taught to adopt a rhythm more in accordance with that of the better workers. This was done by getting them to work to the beating of a metronome, until they acquired the correct rhythm. The miners were taught to use a heavier pick for coal-getting, and a lighter one for dirt. Reliable results showed that in consequence of the adoption of these methods, output increased from 6 to 10 per cent., and in one case, 20 per cent. The experimental periods lasted from six to ten weeks before training, and from four to ten weeks after it. The miners expressed themselves satisfied with the new method of work, as they found it easier and smoother. Other difficulties in coal-getting are under investigation.—H. M. Vernon.

Notes on the Lay-Out of a Hand-Compositor's Case. *Sheila M. Bevington.* Jour. Nat. Inst. Indust. Psychol., Oct., 1922, 1, No. 4, 141-151.—The types in a hand-compositor's case were arranged on a new principle, in order to facilitate access, and to diminish the extent of movement necessary for the transference of type to the composing stick. In comparison with the "Caslon New Lay," which is claimed to be a great improvement on the "Old Lay," the method suggested reduced the average distance travelled by the right arm by 19 per cent. The relative frequency of the letters used was first determined by analyzing representative tests. The logotype combinations, such as "ff" and "fl," were discarded, and were replaced by the logotypes "the" and "and." The actual time saved by the revised lay is not likely to be so great as that corresponding to the diminished movements, since a good deal of the total time taken is occupied in picking up type, and placing it. The method ought to be tested practically on two groups of compositors, trained on the two lays.

INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

State Institute for the Study of Efficiency Engineering and Industrial Hygiene. Jour. Am. Med. Assn., July 22, 1922, 79; No. 4, 318.—A recognition of the impor-

tance of industrial psychology, which, owing to the influence of propaganda from America, is coming to the front here more and more, is the underlying factor that has induced the head committee of the Prussian legislature to adopt unanimously the suggestion of the minister of public welfare that a state institute for the study of labor problems and industrial hygiene be created. The need of applying psychologic principles to all industries was discussed at length, and special reference was made to the excellent results secured in America by the introduction of a practical system of psychology—more particularly, the Taylor system. The Greater Berlin Street Railway Company, by training motormen in accordance with modern psychologic, scientific principles, effected a saving of 12,000,000 marks for the last fiscal year, while the number of accidents was also materially decreased. With greater efficiency, a saving of 10 per cent. in the amount of electric current required was brought about, and the wear and tear on the rolling stock and the roadbed was distinctly reduced. Another great gain lay in the fact that with the application of scientific, psychologic principles the motormen and conductors could be trained for the work in one-third the time formerly required.—K. R. Drinker.

Some Business Applications of a Mental Alertness Test. *A. W. Kornhauser.* Jour. Personnel Res., July, 1922, 1, No. 3, 103-121. —This is a report of methods used and results obtained in some tests of general intelligence made in business establishments during 1919 and 1920. The tests employed were the Scott Company mental alertness tests, which are comprised of tests of arithmetical reasoning, of finding the opposites of given words, of seeing relationships between certain words, counting cubes in pictures, rearranging letters to form words, and solving problems of combining coins. The tests showed high correlation with ratings made by supervisors. Tests made in the educational department of a large plant showed that an examination lasting only twenty minutes approached closely the estimates formed on the basis of school experience, etc. Mental alertness tests were given to 122 foremen taking a course in factory management and modern production methods, and comparison was made with the marks obtained in the course. Similar results were obtained. Tests given to 311 male office employees and 400 female office employees revealed a striking superiority of the men, although men and women students in a co-educational college showed no significant difference in standards. Standards of several occupational groups were determined. Other tests have been made to compare applicants for positions in certain occupations with employees in the same occupation, to compare office employees of different companies, and to determine the relation between mental alertness and turnover.—G. E. Partridge.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

The Acute Painful Back among Industrial Employees Alleging Compensable Injury. *Harold R. Conn.* Jour. Am. Med. Assn., Oct. 7, 1922, 79, No. 15, 1210-1212.— The author sums up his paper in the following conclusions:

Trauma is blameless as an etiologic factor in a large percentage of cases of alleged traumatic backs.

Malingering is of uncommon occurrence, but often is implied to the surgeon by the patient's false conceptions of etiology and an overanxiety to establish the recognition of a real disability.

Osseous abnormalities in the lower portion of the back furnish a potential group, especially susceptible to violence but capable of developing disability unexcited by trauma.

Sacro-iliac relaxations are of infrequent occurrence.

Sacrolumbar lesions are properly of two classes as regards the involvement of the articulation, extrinsic and intrinsic, the latter representing the grave traumatic lesions of most common occurrence.—K. R. Drinker.

Measuring End-Results after Injury: A Suggested Percentage Basis. *John J. Moorhead.* Jour. Am. Med. Assn., Sept. 2, 1922, 79, No. 10, 824.—Surgeons are often called on to determine the end-result of a given injury so that legal, compensation, or insurance phases may become a matter of record or a subject of review by constituted authorities. With this fact in mind, the author submits a simple plan, based on three main elements—function, union, and contour—to determine by a percentage basis the outcome of injuries.—K. R. Drinker.

REHABILITATION OF DISABLED EMPLOYEES

Physical Rehabilitation in Industry. *Oscar M. Sullivan.* Nation's Health, Sept. 15, 1922, 4, No. 9, 560-561.—In this paper the author discusses the relation which should exist between systems for vocational rehabilitation of injured persons and the agencies for physical rehabilitation. In the author's opinion, sound policy dictates an advisory relation to physical rehabilitation upon the part of the vocational rehabilitation system, rather than a relation of direct management. It should be the function of the vocational rehabilitation system to understand all the existing provisions for physical care and to bring the injured person in touch with the proper agencies for treatment or prosthesis at the proper time.—K. R. Drinker.

New Jersey Industrial Rehabilitation Clinics. *Lewis T. Bryant.* Nation's Health, Oct. 15, 1922, 4, No. 10, 610-612.—The Rehabilitation Act of New Jersey has been drawn so as to give the Rehabilitation Commission a tremendous latitude in working out its methods. The disabled man, having received such treatment as the Industrial Clinic deems necessary for the most complete physical rehabilitation, is then taken in hand by the Commission, which makes a study of his case to determine what form of work he is most fitted to do. It is the duty of the Rehabilitation Commissioner to keep in touch with the employment officers of the different industries, and thus place each man in that position to which he is most adapted. The Commission must enjoy the confidence of both the laborer and the employer. Indeed it is through strengthening the morale of the worker who is "down and out," that the Commission has rendered its greatest service.

The industrial clinics as they are organized under the foregoing system have proved to be an essential element in the success of this undertaking, since the general hospital lacks the room, equipment, and nursing facilities which are called for by industrial rehabilitation cases.—L. A. Shaw.

The Treatment of Industrial Accidents. *James R. Kerr.* Brit. Med. Jour., Aug. 26, 1922, 2, 377-380.—Dr. Kerr, surgeon to the Pilkington Special Hospital, St. Helens, an institution devoted to after-treatment of industrial injuries by physiotherapeutic methods, read this paper before the British Medical Association. As this hospital is probably the largest and best equipped of any in the country for its particular purpose, the views expressed are not only interesting in themselves but are particularly so on account of the author's extensive practical experience. He expresses a high opinion of first-aid and ambulance methods and of the universal availability of well-equipped hospitals for early treatment, but considers that the latter could never supply the needs for specialized after-treatment. The variety and severity of factory accidents bear close comparison with those of modern warfare, and the treatments which have proved to be of greatest value to the victims of the latter should be available for any requisite period for those suffering from industrial injuries.

Dr. Kerr explains at some length the course of treatment at this institution. The doctor referring the case, and probably the doctor acting for the employer or insurance company, supply the necessary preliminary information in reports. The examination includes a detailed measurement of the range of movement of each joint, including phalangeal; the state of any nerve lesion is carefully investigated; stereoscopic X-ray photographs

are taken as well as frequent ordinary photographs and plaster casts for purposes of comparison. Where any operative measures are found necessary as a preliminary to special treatment these are carried out. The equipment includes a hall for mechanotherapy fitted up with appliances for helping the movements of stiff joints and the development and re-education of injured muscles. All these mechanisms are finely poised and are capable of delicate and gradual adjustments to suit individual cases. The hall for hydrotherapy contains a warm pool, 36 feet long by 20 feet broad, maintained at a temperature of 98°F. and kept in a state of turbulence by forcing in great volumes of compressed air through orifices in side pipes. There are lounge seats for helpless patients. This hydro massage has been found very useful in encouraging active movements in hip and shoulder joints. An adjoining room contains an ample supply of multiple baths for arms and legs. In the thermotherapeutic department there are asbestos-lined cabinets for enclosing the parts under treatment, these being supplied with hot compressed air, at a temperature of 250° to 300° F., through regulated electric heaters. There is also a room for electrotherapy.—W. F. Dearden.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

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CONTENTS

GENERAL

THE SCOPE OF THE PROBLEM OF INDUSTRIAL HYGIENE. *Alice Hamilton.* U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2604-2608.—The fields which have been surveyed in the United States include certain of the poisons and very few of the dusts; the organic dusts belong to a field still to be explored. Since the war, the use of benzol in this country has increased enormously, and benzol is definitely poisonous. Yet a thorough investigation of benzol poisoning in the United States is still to be made. Arseniuretted hydrogen is a less familiar poison but may be present in many chemical processes. Adequate ventilation can remove this hazard. Emphasis is laid upon the necessity for studying American men and women and American industry.—B. Cohen.

THE NEED OF EDUCATED PUBLIC OPINION IN INDUSTRIAL HYGIENE. *Rachelle S. Yarros.* U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2636-2639.—All groups, employers, employees and the neutral public, need to be educated with respect to the facts and ideals of industrial hygiene before rapid progress can be expected.

THE RESPONSIBILITY OF THE WORKER IN PROMOTING INDUSTRIAL HYGIENE. *M. Grace Burnham.* U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2618-2621.—A description is given of the Workers' Health Bureau, which is a co-operative trade-union health-research agency. The plan of the bureau is to gather information on specific trades for trade unions and to plan a preven-

tive industrial health program to serve the worker the remainder of his life.

The Responsibility of the Employer for the Health of the Worker. *E. C. Jackson.* U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2613-2618.—The employer should provide suitable, safe, healthful buildings as work places, and well-guarded machines and suitable tools. He should (1) see that all body and health hazards are reduced to a minimum; (2) choose intelligent and sympathetic foremen, who can give the workers the personal contact so necessary for contentedness and efficiency; (3) make an effort to place workers at tasks that suit them mentally as well as physically; and (4) spare no effort to protect the workers from communicable diseases. The prevention of disease through physical examinations and through suitable rest periods should also not be overlooked.

The Functions of the United States Public Health Service in the Field of Industrial Hygiene. *L. R. Thompson.* U.S. Pub. Health Ser., Pub. Health Rep., Oct. 20. 1922, 37, No. 42, 2631-2636.—The Public Health Service is the agency that can most economically co-ordinate the practice of industrial hygiene in industry, city, state, and nation. Industrial laws of different communities are different. Which is the best code is a matter for investigation best performed by a central federal agency. The laboratory investigation of industrial poisons and diseases, and consulting service to industry are other fields for usefulness of the Public Health Service. Supervision over government employees by the Public Health Service for purposes of detecting industrial disease, for purposes of determining disability compensation, and for first aid would be a great step forward. This phase requires authorization by law.

Conference of Women's Advisory Council to the United States Public Health Service on the Subject of Industrial Hygiene. U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2601-2644.—The aim of this conference was threefold: first, that the various national organizations of women might understand the work being carried on by the Public Health Service; second, that the Public Health Service might know what was being done by the national organizations; and third, that through mutual knowledge a clear understanding of each other's aims and a co-ordination of programs might be reached.

Briefly, the plan of work consists of investigation of the amount of time lost by illnesses; classes of diseases prevalent among employees; the connection between certain occupational groups and certain diseases; and the underlying cause of work processes which contribute to the diseases.

It consists further of the study of compensation paid to government employees, including (*a*) a comparison of the amounts of compensation paid in different bureaus of the government per thousand employees; (*b*) a study of the diseases or injuries for which compensation is paid; and (*c*) a study of the work processes in different bureaus and their special relation to compensable disability.

Lastly, it consists of an establishment of dispensaries for emergency treatment, and the treatment of beneficiaries of the United States Employees' Compensation Commission.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Studies in Carbon Monoxide Asphyxia. II. The Growth of Neuroblast in the Presence of Carbon Monoxide. *H. W. Haggard.* Abstracted as follows from Am. Jour. Physiol., 1922, 60, 244, in Med. Science, Oct., 1922, 7, No. 1, 70.—By experiments on *in vitro* cultures it was shown that carbon monoxide by itself has no ill effect upon growing nerve-cells, even in concentrations of 79 per cent. It is in this respect as neutral as nitrogen. Its toxic action on the body as a whole is due solely to the asphyxia resulting from its combination with hemoglobin. Illuminating gas, however, contains, in addition to carbon monoxide, another toxic substance, for it is toxic to neuroblast cultures in concentration of as little as 0.1 per cent.

It is specially stated that this observation is

not to be interpreted as weighing against the view that the toxicity of illuminating gas on the entire organism is due to the carbon monoxide and the asphyxia which it produces.

Suffocating Gases and their Antidotes. *C. J. Van Nieuwenburg.* Abstracted from Chem. Weekbl., 1922, 19, 326-333, in Chem. Abstr., Oct. 20, 1922, 16, No. 20, 3518.—Nieuwenburg reviews the development of the manufacture of suffocating gases and of protective masks, and explains their application during the war.

The Rate of Absorption of Poisonous Amounts of Carbon Monoxide by the Blood. *A. P. Vale.* Tr. Inst. Min. Eng., 1922, 63, 417-422.—The author, working at the Birmingham Mining Research Laboratory, subjected himself to the influence of measured amounts of carbon monoxide in a closed chamber. Two sets of experiments were carried out: one in which the subject was at rest; the other in which 5,000 foot-pounds of work per minute were carried out on a Martin's ergometer. The conclusions were:

1. Where no work is undertaken in atmospheres containing carbon monoxide up to 0.114 per cent. a maximum of 50 per cent. of the amount inhaled will be absorbed.
2. Where work is undertaken, owing to the increased frequency of respiration, the actual amount of carbon monoxide absorbed may be from two to four times as much as when at rest.

It follows that no one should go into a suspected atmosphere unless accompanied by a small warm-blooded animal, preferably a linnet. A mouse or bird at rest absorbs carbon monoxide fifteen times faster than a man at rest. In rescue work the man is working, the animal resting. The factor of safety will be reduced by one fourth and when the animal collapses the explorer should return at once.

Later Effects of Gas Poisoning. *T. W. Sandall.* Abstracted as follows from Lancet, Oct. 21, 1922, 203, No. 5173, 856, in Jour. Am. Med. Assn., Nov. 25, 1922, 79, No. 22, 1882.—In nearly half the cases (46 per cent.) investigated by Sandall there is evidence of emphysema or chronic bronchitis or both. In his opinion pulmonary tuberculosis is not a common effect of gas poisoning, and certainly not one of its later effects. In nearly half the cases (45 per cent.) there is definite tachycardia. In 85 per cent. of these tachycardia cases no sign of anything abnormal was found on examination of the heart. The persistence of gastric symptoms raises the question of organic or functional causation. Another interesting point is the pain in the chest of which complaint is so frequently made. Is such pain any evidence of myocardial involvement, or is this also merely a functional manifestation? With reference to prognosis, more especially in those cases in which physical signs are absent or very indefinite, Sandall asks, does the element of "pension" operate as a factor in the causation or continuance of symptoms?

A Case of Paralysis of Axillary Nerve as the Result of Carbon Monoxide Poisoning. *Ernst Mendel.* Klin. Wchnschr., April 1, 1922, 1, No. 14, 685.—Dr. Mendel reports a case of paralysis of the left axillary nerve in a young married woman brought to the hospital in coma from carbon monoxide poisoning. Movement of the left arm was normal after resuscitation, but in several days weakness developed as a result of paralysis of the middle deltoideus. There was no local tenderness and galvanic reactions were normal. After six weeks of treatment with electrotherapy and hydrotherapy, movement was again normal. In the author's opinion the paralysis is a purely toxic one.—J. W. S. Brady.

Chronic Carbon Monoxide Amblyopia. *Henry M. Thompson.* Colo. Med., July, 1922, 19, No. 7, 145-147.—This article presents a confused idea concerning the action of carbon monoxide. A short general discussion is followed by the report of a case of impaired vision in a garage worker. Several inaccurate statements occur, as, for example, that 4 per cent. carbon monoxide is fatal to man in an hour (this is ten times the fatal dose); also, that carbon monoxide forms a reasonably stable compound with hemoglobin. Physiologists well know that this compound is not stable and that oxygen replaces the attached carbon monoxide in accordance with known physical laws when the patient breathes fresh

air. In the case reported it is pure assumption to state that carbon monoxide was the cause of the impairment of vision.—H. S. Forbes.

Tests of Gas Masks and Respirators for Protection from Locomotive Smoke in Railroad Tunnels, with Analyses of Tunnel Atmospheres. *A. C. Fieldner, S. H. Katz,* and *S. P. Kinney.* U. S. Bur. Mines, Tech. Paper 292, April, 1922.—It is shown that the objectionable or dangerous constituents of locomotive stack gases are carbon monoxide and sulphur dioxide which, coupled with the high temperature and high relative humidity frequently encountered in tunnels, often cause serious consequences and even fatalities.

Samples of tunnel air were taken under the most severe working conditions to which engineers and firemen are often subjected. The analyses showed that carbon monoxide in one instance reached a figure of 0.12 per cent., at which it caused marked discomfort but was not dangerous when breathed for only a short time.

Sulphur dioxide was found in one instance to be as high as 110 parts per million, but was usually found in smaller quantities. Because temperatures as high as 131° F. were found in the cabs of locomotives, the authors suggest that these temperatures, together with the exhaust steam from the locomotives, may have been the cause of frequent accidents due to inadequate tunnel ventilation.

The authors, a number of engineers, firemen, and trackworkers, tested several types of gas masks. Men doing vigorous work seemed to favor the light gas masks with canisters of about one-fourth the capacity of the canisters in the usual army gas mask. For absorbents the canisters were provided with charcoal and soda-lime which gave adequate protection against sulphur dioxide and smoke. For tunnels in which a high carbon-monoxide content is feared the authors suggest the use of canisters containing hopcalite, a mixture of the oxides of manganese, copper, silver, and cobalt. Either electric locomotives or forced ventilation are suggested as the most effective cure for the extreme conditions occasionally encountered.

Several illustrations and drawings of gas masks are included in the paper, and a bibliography is appended.—Philip Drinker.

DUST HAZARDS AND THEIR EFFECTS

Atmospheric Dust. *J. S. Owens.* Jour. Soc. Chem. Indust., Oct. 31, 1922, 41, No. 20, 438R-443R.—This paper, read before the chemical section of the British Association at Hull, is a discussion of atmospheric dust from the standpoint of meteorology. The author deals principally with dust in its relation to atmospheric pollution, the cause of hazes, fogs, etc.; he furnishes data obtained by the use of his instrument (to be described in an early issue of this Journal) regarding the size and identification of both soluble and insoluble dusts of which the particles are less than 1 micron. The usual size of fog particles (soot) was found to be about 0.5 micron. Data indicate that volcanic dust is a probable cause of haze in certain localities, and show the distances through which volcanic dust has traveled. The author suggests using his instrument for calibrating the efficiency of air washers but gives no data regarding its use therefor. Because of its sensitiveness this instrument is poorly adapted to counting particles of appreciable weight in volumes of air.—Philip Drinker.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Annual Report for the Year 1921 of the South African Institute for Medical Research.—This report contains a summary of the work carried out during the past year. Particular attention may be drawn to further inquiries into infective silicosis:

Animals that had been exposed to dust of coal or silica were given intraperitoneal inoculations of the bacillus tuberculosis, as to one series, and intratracheal injections of streptococci and pneumococci as to another. Control animals that had not been exposed to

dust were given corresponding inoculations or injections.

The animals that had been exposed to coal and then inoculated with bacillus tuberculosis all died of generalized caseous tuberculosis, the lungs being grossly involved. Observers have recorded that animals that have been exposed to coal dust and then inoculated with bacillus tuberculosis die of tuberculosis but that the lungs escape. The animals subjected to intratracheal injections of streptococci or pneumococci after exposure to inhalations of coal dust either died of pneumonia within forty-eight hours or recovered completely. The results were similar to those in the controls in both cases.

The animals that had been exposed to inhalations of silica dust and then inoculated with bacillus tuberculosis reproduced miners' phthisis very closely. They died of tuberculosis, with bulky lungs, thick pleurae, and well-marked fibrosis; the tuberculous lesions, however, were generalized throughout the body. Perhaps the most striking feature was the rapid development of fibrosis. In animals that have been merely exposed to the inhalation of silica dust the fibrosis is not detectable until about seven months after commencement of exposure, but if a tuberculous infection is added fibrosis can be detected within five weeks, and is far more marked at death than in animals that have merely received a tuberculous infection.

In the case of animals which received intratracheal injections after "dusting" with silica, three died within forty-eight hours, and three at the end of about seven months. The latter died of a chronic, unresolving pneumonia.

All the foregoing experiments were performed upon guinea-pigs.

A somewhat similar series was carried out with rats, more especially with a view to learning whether exposure to silica dust would influence the relative immunity of these rodents to tuberculosis. The rats exposed to coal dust, and the controls, did not develop tuberculosis after inoculation. Four out of six rats which had been exposed to silica dust died of tuberculosis of the lungs, without tuberculous lesions elsewhere in the body.

ANTHRAX. *R. F. Vaccarezza et al.* Abstracted as follows from Semana méd., June 29, 1922, 1, No. 26, 1081, in Jour. Am. Med. Assn., Oct. 28, 1922, 79, No. 18, 1557.—This is the concluding instalment of this detailed report of extensive experience with treatment of anthrax by specific antiserum, normal beef serum and peptone. The writers are convinced that serotherapy is merely a form of protein therapy, and hence that any protein would probably answer the same purpose. Peptone is free from the disadvantages of other proteins, and their tabulations show that it is fully as effectual as the specific antiserum.

THE SERUM TREATMENT OF ANTHRAX SEPTICAEMIA. *Douglas Symmers.* Ann. Surg., June, 1922, 75, No. 6, 663-667.—The author points out that the pustule of cutaneous anthrax frequently heals spontaneously if it is left to its own devices and not subjected to operation or cauterization, either of which may precipitate septicemia, which is almost always fatal.

The author concludes as follows:

1. Every anthrax lesion of the skin or elsewhere should be tentatively regarded as attended by generalized infection until the result of the blood culture proves the contrary.

2. In no circumstances is it justifiable to tamper with the anthrax pustule. The only permissible form of local treatment consists in the injection at the periphery of the pustule of broken doses of anti-anthrax serum at intervals of four or six hours, each injection not to exceed a total of 10 or 15 c.c. If this is not available, it is better to cover the lesion with a bit of sterile gauze to collect the secretions, but otherwise to leave it alone.

3. The best treatment is, first, to isolate the pustule within a barrier of anti-anthrax serum subcutaneously injected every four hours; second, to inject intravenously, at once, a sterilizing dose of 150 or 200 c.c. of serum, and, third, to supplement this by the intravenous injection of 40 c.c. every four or eight hours. If the blood culture is negative at the end of twenty-four hours, the intravenous use of serum may be discontinued, the local injections being kept up until the pustule is free from bacilli, or at least until involution forms occur in the stained films. In anthrax septicemia, the liberal use of anti-anthrax serum intravenously, if commenced in time, is capable in many instances of steril-

izing the blood with astonishing rapidity, and, in septicemic cases, the routine just outlined may be followed until the blood cultures are negative.

The Place of Venereal-Disease Control in Industry. *Joseph S. Lawrence.* U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2609-2613.—Venereal disease may be slightly more prevalent among industrial workers than among certain other occupational groups. This increase is not due to their work, but to the unsatisfactory conditions surrounding their efforts at rest or recreation. The diseases occasion only slight economic burden in loss of time when compared with other diseases. Because of its insidious development, however, syphilis may be the cause of many accidents.—B. Cohen.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Occupational Dermatitis. *Frederick Gardiner.* Brit. Jour. Dermat. and Syph., Oct., 1922, 298-320.—This comprehensive paper includes the earlier work published by the writer on this subject, and also contains much new matter. It reviews 621 skin diseases seen by him during the last ten years. All were caused by occupation—domestic, trade, agriculture, etc. The great bulk of this material is drawn from an extensive, but generally speaking, a non-manufacturing area. Discussing the statistics of a single year (1919) he finds that 68 per cent. of all the cases diagnosed as dermatitis, or eczema, were due to occupation. Under this heading the numbers are as follows:

Occupations	No. of Cases
Housewives	254
General laborers	59
General	51
Iron and steel workers	36
Colliery workers	32
Mill workers	26
Chemical workers	25
Rubber workers	24
Bakers	16
Painters and French polishers	14
Agricultural laborers	14
Woodworkers	13
Printers	12
Butchers	12
Tailors	8
Chocolate makers	6
Leather workers	6
Munition workers	4
Linoleum workers	4
Upholsterers	3
Actors	1

Instances are described in detail of persons who have suffered, it may be for years, from some external irritant. This, the author says, so weakens the resistance of the skin, that the individual becomes highly susceptible to a different agent. Once an outbreak has been produced on a skin, it becomes sensitive to an irritant to which it was previously immune.

The whole of his series of cases is minutely analyzed. Separate tables show the different parts of the body affected, the ages at which onset occurs, duration of the attacks, seasonal prevalence, effect of slight alteration in the work, and predisposing causes. All these various aspects of the subject are examined and illustrated but do not readily lend themselves to abstraction. They supply a fund of useful information which no clinician can afford to ignore.

The outstanding feature of Dr. Gardiner's communication is that he has investigated each case from the point of view of the skilled dermatologist. He has endeavored to find out, not only the direct influence of the irritant, but the rôle played by unhealthy states of the body, or of the skin, in promoting the onset of these troubles. He finds that lowered vitality, such as that which follows influenza or pneumonia, accounts for 13.8 per cent. General debility arising from the menopause, old age, or an injury may be the prelude to an outbreak. Further close consideration of his cases reveals to him that a large number are associated with some local morbid condition of the skin. Of these the most common is seborrhea, with 28 per cent. Excessive sweating is the next most frequent concomitant showing 27 per cent. This may result from debility, the hot materials handled, or may be due to some unknown, or inherent peculiarity.

In the final review of his figures he sums up these significant factors. He says that "77.4 per cent. of these patients suffered from a preceding skin affection, or general illness.

. . . This percentage is a very high one indeed and it provides food for reflection." It is certainly true that an ordinary report upon an occupational dermatosis rarely alludes to a preceding illness, the texture, or pathological state or tendency of the individual skin. The reason is not far to seek. The usual observer is not necessarily or even generally an expert or one specially trained in this line of inquiry. Gardiner feels from this standpoint that the professional disorders of the skin have been neglected by previous investigators. These considerations urge him to stress the great necessity that exists for a much more thorough examination of candidates for various trades, especially where the applicant is to be exposed to the known skin irritants.

He concludes as follows:

a. There are definite occupations which are liable to cause damage to the skin.

b. Some irritants act mechanically and others act chemically.

c. Alterations in the materials used may cause the development of a dermatitis in the case of a worker employed for many years at the same occupation.

d. A previous dermatitis may subsequently render a worker susceptible to an irritant which he or she could previously resist.

e. It is characteristic of occupational dermatitis that it occurs on the parts exposed to the irritant; the majority of cases occur on the hands, and next in order of frequency on the arms, face, neck, and lower extremities.

f. Spread may be from the irritant itself, or may be due to secondary infection.

g. The attack may commence in youth, but if not it is more common in persons over 40 years of age.

h. The recurrent type is an exceedingly common one.

i. Dermatitis, in the case of a powerful irritant, may ensue within a day or two; where there is hyperidrosis it is likely to appear within a few weeks; where there is seborrhea there is a more gradual breakdown, maybe over months or years; the largest number occurs after many years, owing to various causes.

j. Illness, the climacteric, and old age are important points in the causation of an outbreak.

k. Local injury is also an important factor.

l. The condition of the skin should be a matter of close examination in all applicants for occupations which incur liability to dermatitis.—R. P. White.

THE OCCUPATION DERMATOSES OF THE PARAFFIN WORKERS OF THE SCOTTISH SHALE OIL INDUSTRY. *Alexander Scott.* Brit. Med. Jour., Aug. 26, 1922, 2, No. 3217, 381-385.—Dr. Scott describes the skin lesions due to contact with oily paraffin in a crude or semi-refined state as conforming to the following types, of which only one or several might be found on the same individual:

1. Occupation comedones.
2. Folliculitis and follicular dermatitis.
3. Dermatitis pustulare.
4. Dermatitis papulare (erythema papulare).
5. Erythema simplex.
6. Dermatitis erythematosa.
7. Epithelioma (paraffin workers' cancer).

1. Comedones occurred in parts exposed to contact, especially over the flexures and posterior aspects of the elbows, upper aspects of shoulder joints, and occasionally over the knees. Their origin was due to obstruction of the sebaceous ducts with semi-solid paraffin substances, or to thickening of the superficial layers of the epidermis. They were larger than ordinary, more closely packed together, and confined to circumscribed areas. The outer layers were pigmented and hardened. They were easily expressed, but if left alone were apt to be followed by the development of sebaceous concretions of a cystic nature, most commonly over the flexures of the elbows. There was not the ordinary tendency to acne formation, possibly owing to the fact that the obstructive material was sterile and practically antiseptic.

2. Folliculitis involved destruction of the hairs and hair follicles as the result of a mild inflammatory reaction set up by the action of shale oils. Occasionally a slight perifolliculitis occurred, in which the inflammatory condition extended to the surrounding skin, which became slightly raised and ultimately somewhat indurated and thickened. The common sites were the backs of the fingers and hands, and to a less degree the forearms, the ankles, and the dorsal aspects of the toes and feet, especially on the line of the extensor tendons of the toes. There was never any tendency toward suppuration or sloughing, the

condition described persisting indefinitely. Dryness of the hands, with clusters of black points on the backs of the fingers and hands was characteristic.

3. Two types of pustular dermatitis have been observed: one, affecting the hair follicles of youths recently commencing work among semi-refined oily paraffin, in which the condition was characterized by the appearance of numerous small pustules over the anterior aspect of the body and limbs; the other, in association with the typical papular eruption, due to the breaking down of the papule from coccal infection.

4. The papular variety was by far the most common type of skin lesion met with among paraffin workers in the Scottish shale oil industry, between 40 and 50 per cent. being affected. The papules were known in the trade as "paraffin plukes," and were most typical of an occupational condition both in history and distribution.

The eruption consisted of small rounded elevations of a reddish color, varying in size from that of a small peppercorn to that of a small pea. They corresponded in every way to typical papules, being solid, superficial, rounded, and containing no fluid. As a rule the tops were convex, but occasionally there was a minute central depression, corresponding to a necrosed hair follicle or sweat duct, from which a tiny thread-like core could be expressed or removed.

The entrance of the irritant to the superficial layers of the skin appeared to be most commonly through the sweat ducts, but frequently the hair follicles were involved, in which case they occupied the center of the papule. There was, as a rule, no inflammatory areola around the typical papule. The condition differed from other lichenoid eruptions, in that there was no itching or irritation; the papules did not tend to coalesce, and as a rule healed spontaneously. The extent of eruption varied, but in half the cases only a few papules were to be found and only 5 per cent. showed a diffuse character.

The distribution was very typical. In the great majority of cases it was confined to the forearms and was most pronounced over the ulnar aspects. The palms of the hands and soles of the feet were never affected. Approximately 75 per cent. of those affected had an eruption on the hands and arms only; 20 per cent. had both arms and legs affected; and about 5 per cent. had some eruption on the body, as well as on the arms or legs.

The earliest appearance of papules occurred in from ten to twelve days after work in the paraffin sheds was begun, and they might persist throughout the duration of employment. They disappeared a few weeks after work among the semi-refined paraffin had ceased. Occasionally in old-standing cases the papules, instead of healing, assumed a warty appearance. This condition might spread until it assumed the clinical and pathological features of an epitheliomatous growth.

5. Mild erythema, in which the redness was distributed uniformly over the parts affected, disappearing on pressure at first but later becoming permanent, was almost always limited to the forearms, but in exceptional instances and to a slight degree had been seen on the feet. There were marked dryness and scaliness of the skin and frequently a polished appearance; irritation was uncommon. The whole condition might persist for years without alteration.

6. Dermatitis erythematosa was essentially of a subacute or chronic type, due to the irritant action of semi-refined paraffin on the tissues of the skin prolonged over a lengthened period—for years in practically every instance. It represented a further extension of erythema, in which the congestion, after merging into a chronic inflammation of the various layers of the epidermis and cutis vera, was followed by induration and, in the most advanced stages, by partial or complete destruction of small areas of the affected skin. It was mostly associated with the papular eruption.

In an advanced stage the forearms showed pigmented patches, small white areas of atrophied skin, scars, scaly warts, and indurated papules. The condition had become less evident and was practically confined to those who had been paraffin workers for years.

7. Epithelioma as seen in the Scottish oil industry occurred in workmen about or over middle life who had been paraffin workers for long periods of time. It usually arose from a scaly wart formed as a result of the chronic dermatitis already described, or from an old papule of the indurated type. In the benign condition the wart was somewhat oval

or circular, about the size of a sixpence and covered by small readily removable scales. As the epithelium underwent proliferation the wart increased in area until it reached the size of a half crown and became raised about a quarter of an inch above the surface. It was then covered with thick horny scales and showed a tendency to the formation of fissures or abrasions, from which a serous fluid exuded and formed crusts on the surface. This appearance persisted for several months, the area gradually increasing until the incrustation and warty covering of the growth eventually sloughed and disappeared, leaving a superficial ulcer, from which serosanguineous fluid exuded.

In an indurated papule a central necrotic area formed, accompanied by the gradual growth of the primary lesion until it assumed much larger proportions than formerly and had a central ulcer, surrounded by indurated edges. The growth of the ulcer extended peripherally and also in depth, the edges being indurated and undermined, until all trace of elevation of tissue above the level of the surrounding skin had disappeared, leaving a large open sore with a base of red, angry-looking granulation tissue which bled profusely at the slightest touch.

When situated on the scrotum, there was usually, in the ulcerative stages, an overgrowth of epithelial tissue forming large protruding masses, giving the appearance of a cauliflower excrescence, and bleeding profusely. Ultimately the lymphatic glands were involved, so that in the latest stages the whole inguinal region was invaded by a large ulcerating cauliflower-like mass. The most common situation was the back of the hand or on the lower third of the forearm, but it did occur on the scrotum, and it had been seen on the face; when at the outer or inner angles of the eyelids, the features of a rodent ulcer might be assumed. Since 1900, sixty-five cases of paraffin epithelioma had occurred in the oil works of Scottish Oils Limited, nineteen being in paraffin workers proper, and forty-six among the other grades of labor. The number of employees being 5,000 the cancer incidence was approximately 1½ per cent. in twenty-two years, or under 0.1 per cent. per annum. Nineteen cases occurred in the same period among the 200 men employed annually in green sheds (paraffin sheds of crude paraffin department), the incidence rate of this condition was thus approximately 0.5 per cent. per annum. In the cases recorded the ages varied from 37 to 79 years.

It was formerly believed that the shale itself was the cause of the dermatitis, but recent experiments with animals have clearly showed the oil to be the agent, though the actual constituent responsible has not yet been determined. Dr. Scott gave reasons why nitrogenous compounds, arsenic, or radio-active substances could not be regarded as causative agents. He suggested that an idiosyncrasy existed toward the action of paraffin substances, and that the personal element was a factor of some importance in the development of warts and papules into epitheliomata.

He mentioned the importance of cleanliness as a prophylactic measure and said that while this had only slightly diminished the incidence of early eruptions, it had brought about a marked decrease of the more chronic types.

Regarding seasonal conditions, the warty excrescences were more numerous during winter and spring than in summer. Concerning protective measures there were adequate facilities for ensuring absolute cleanliness of bodies and clothing, for protecting the exposed parts, and for medical inspection every three months. The best protective application appeared to be castor oil, which, owing to its insolubility in paraffin, provided an impervious covering. No form of clothing has been found to withstand the extremely searching and solvent action of the paraffin series.

The various methods of treatment were purely local, and carried out on ordinary lines. Occupational comedones were readily removed by expression; papular conditions disappeared when work was discontinued, and as a rule required little or no treatment; mild antiseptic pastes, such as boric ointment, sufficed to prevent septic infection. In the more acute erythematous conditions, sedative applications were of use, the most effective being preparations of ichthyol and lead. These, as well as pastes of zinc oxide and salicylic acid, were also useful in chronic types; stronger preparations of the last were needed for wartiness. In the more rapidly proliferative warty conditions, salicylic and chromic

acids readily removed the superficial varieties, but when warts extended more deeply into the skin carbon dioxide snow was better. When warts or nodules proliferated too rapidly, removal by excision was a sure treatment, and it was exceptional to find recurrence.—W. F. Dearden.

Pseudosclerosis with Corneal Pigmentation and a Haze on the Lens Visible only on Oblique Illumination, and Resembling a Condition Produced by the Presence of Copper in the Eye after Perforating Injuries. Abstracted from Klin. Wchnschr., 1922, 1, 1087, in Med. Science, Nov., 1922, 7, No. 2, 148-149.—The authors describe the case of a man of 43, employed in a brewery and in the habit of drinking daily 4 liters of beer and of smoking excessively, who, for six years before the examination now reported, had gradually developed tremor of the head and limbs. At the end of this period he presented a Parkinsonian facies and widespread tremor. Case findings are given. Examination of the eyes showed the presence of the characteristic green-brown pigment ring at the periphery of the cornea, and also a blue-gray haze on the surface of the lens resembling a sunflower in outline. This was visible only on oblique illumination. The authors point out that the lens condition exactly accords with that described some years ago by Purtscher as indicating the presence of minute fragments of copper in the eye in cases of perforating injury, and occurring apart from the presence of copper in the lens itself. Since this haze differed from all other forms of lenticular opacity in being invisible by transmitted light, that is, an ophthalmoscopic examination—Purtscher spoke of it as an "apparent cataract." The scope of the discussion is restricted to German writings only.

OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

"Accident Prevention," a Branch of Welfare Work, II. *D. D. Goldingham.* Industrial Welfare, Sept., 1922, 4, No. 9.—This is the second article of a series. According to the first article, 79.42 per cent of industrial accidents are non-mechanical; hence, if all machinery could be enclosed in cast iron, a large percentage of accidents would still occur. The public are all chance takers. Various causes of accidents resulting from chance taking are enumerated, and attention is drawn to the importance of education of the human factor. The author states that education is the basis of safety. A table of the fifteen most frequent causes of disability among 1,282 office employees of a large manufacturing company for one year is given.—E. M. Hewitt.

Pillarless Electric Miners' Safety Lamps. Miners' Lamps Committee. Iron and Coal Trades Rev., July 7, 1922.—The Secretary of the Mines Department has approved the recommendation of the Miners' Lamps Committee that pillarless lamps should be accepted for the official test for use in coal mines. The Miners' Lamps Committee has experimented with this type of lamp for the last two years and has come to the conclusion that the lamp is safe for underground use and that the proportion of broken glasses is not greater than that of the ordinary type of lamp. In the standard pattern of safety lamp the top of the glass is protected by a metal plate supported on pillars. In the pillarless type the lamp glass is dome shaped and uncovered. The light given is distributed in all directions and is free from shadows.

The lamp is greatly appreciated by those miners who have worked with the lamps during the trials. It is hoped that an improved allround illumination will be obtained.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Effect of Alcohol on Industry. *Edgar L. Collis.* Indust. Welfare, Sept., 1922, 4, No. 9.—Evidence from America points out that labor turnover is less under prohibition, and

that regularity of attendance is greater. The most important test is the productivity of the workers. Valuable evidence on this point is based on laboratory observations of effects on skilled movements and of efficiency of physical effort. Figures with reference to accidents appear to show a reduction when there is abstinence from alcohol.

Dr. Collis concludes that "industrialism in so far as it has led to bad social conditions and to bad feeding, and has caused over fatigue, has conduced to alcoholism. . . . Alcoholism so caused has reacted and is continuing to react harmfully upon industrial productivity. On the other hand, when, owing to industrial influence, social conditions have been improved . . . industry has exerted, and may continue to exert, a powerful influence in restraining alcoholism within reasonable bounds."—E. M. Hewitt.

Tests for Physical Efficiency. *W. D. Hambly, G. H. Hunt, L. E. L. Parker, M. S. Pembrey,* and *E. C. Warner.* Guy's Hosp. Rep., Oct., 1922, 72, No. 4, 367-385.—Just as in the case of temperature and other physiological processes, experiments gave no definite normal for the pulse. The average pulse rate is lower for heavier individuals; but weight is not the factor so much as the relation between surface and mass. The pulse of trained persons is definitely slower than that of the untrained. In these tests the average rate per minute for trained men was 61; for untrained, 72; and for unfit, 81. For trained women the average was 75; and for the untrained, 84. The rate varies with age, slowing with advancing years from 71.5 for trained men under 20 years of age to 63.7 for those aged 30 and over. A rise in atmospheric temperature is followed by a rise in pulse rate.

The relation of the pulse rate at rest to that after exercise was carefully studied. The exercise chosen was stepping on and off a stool 13 inches high at fixed rates per minute; then the pulse was taken every thirty seconds for the next two minutes. The pulse-ratio—that is, the ratio between the pulse rate for the two minutes immediately following a given mild muscular exercise and the pulse at rest—was found to be a good indicator of physical fitness. Strenuous exercise, as, for instance, running a mile, produced in the fittest men the greatest percentage rise in pulse rate and afterwards the greatest percentage fall toward the resting value. A low resting pulse rate in an athlete, giving a greater range before the speed limit of the heart is reached, is a great advantage.—E. L. Collis.

Industrial Fatigue and Vocational Selection on a Basis of Physical Inquiry. *David McKail.* Brit. Med. Jour., Aug. 26, 1922, 2, No. 3217, 351-355.—In a discussion on this subject at the recent Annual Meeting of the British Medical Association, Dr. McKail distinguishes between the extreme form of industrial fatigue—which he regards as bordering upon the pathological and due to the continued toxemia resulting in ultimate physical deterioration but from which, owing to improved conditions, the present generation cannot be said to suffer in any marked degree—and the minor form which is more strictly physiological. The effects of the latter are mostly subjective and personal to the worker, and are, therefore, not so easily recognized by the observer as the more severe type. It has thus become necessary to redefine the term, which, in the words of the Health of Munition Workers Committee, now covers "the sum of the results of activity which show themselves in a diminished capacity for work." He outlines the difficulties that arise in attacking the problems as they exist, and proceeds to deal with the relationship to fatigue of (*a*) the hours of labor, (*b*) other conditions of employment, and (*c*) methods of work. Accepting the eight-hour working day, he outlines the following alternative schemes for dividing the twenty-four hours into the most suitable periods for work, rest, nourishment, and recreation, stating his preference for the first arrangement as conforming more to established meal hours.

6 A.M.	Rise, wash and dress; light breakfast	7 A.M.
7 to 9 A.M.	Morning spell of work	8 to 10 A.M.
9 to 10 A.M.	Breakfast and rest pause	10 to 11 A.M.
10 to 1 P.M.	Forenoon spell of work	11 to 2 P.M.
1 to 2 P.M.	Dinner and rest pause	2 to 3 P.M.
2 to 5 P.M.	Afternoon spell of work	3 to 6 P.M.
5 to 6 P.M.	Tea and rest pause	6 to 7 P.M.
6 to 10 P.M.	Rest and recreation	7 to 11 P.M.
10 to 6 A.M.	Sleep	11 to 7 A.M.

Spells of work should be normally from two to three hours in length in all occupations

demanding steady application and attention. In arduous work there must be rest spells after excessive exertions, and the latter must not be unduly prolonged. Confinement and want of variation induce languor and dullness; continuance of work thereafter can only be accomplished by the exercise of superior or excessive mental stimuli, and the resulting fatigue is more slowly recovered from. In arduous work a four-hour spell should not be allowed where labor is continuous.

Definite intervals for meals must be provided. For work starting before 9 A. M., two meal periods should be interposed in the timetable; few persons take a normal amount of food in the morning, and it is too long to work a three-hour or a four-hour spell before again getting food. For the eight-hour day a three-spell day is, therefore, recommended, the first of two hours, and two of three hours each. For a nine-hour day, the first spell may be two and a half hours, and the others three and a quarter hours each. If an industry can give a living wage on shorter hours this should be done, and the morning spell abolished.

An objection to the 7 to 9 A. M. spell is that it increases the stoppages and starts, and working time is always lost at those periods. The main objection to the three-period day with two breaks comes from those who believe that after every start there is a "warming-up" time required, and that the repetition of this results in serious loss of working time.

Conditions of employment, especially in hazardous occupations, should be good; if these conditions cannot be secured, the industry should be suppressed. Methods of work are worthy of study, in order to eliminate waste of energy, to find the best methods, and to avoid harmful movements.

Vocational selection must at present be limited to the "don't" department. Young persons with certain defects should not be permitted to engage in specified employments. —W. F. Dearden.

THE RELATION OF THE ADRENALS TO FATIGUE. *F. A. Hartmann, R. H. Waite,* and *E. F. Powell.* Abstracted as follows from Am. Jour. Physiol., 1922, 60, 255, in Med. Science, Oct., 1922, 7, No. 1, 78.—In cats one adrenal was removed, the other was denervated so that the output of epinephrin was greatly diminished. Such cats often show a period of ill health, indicated by loss of appetite, loss of weight, change of temperament, weakness, and sometimes a subnormal temperature. Their capacity for muscular work is diminished. Observations on normal cats doing muscular work show that an increased resistance to fatigue is associated with an increased output of adrenalin, as indicated by the denervated pupil reaction.

Adrenalin plays, therefore, an important part in increasing the capacity for muscular work and delaying the onset of fatigue.

HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

COMPRESSED-AIR ILLNESS AND ITS ENGINEERING IMPORTANCE WITH A REPORT OF CASES AT THE EAST RIVER TUNNELS. *Edward Levy.* U. S. Bur. Mines, Tech. Paper 285, Feb., 1922, pp. 48.—Compressed-air illness, or caisson disease, is caused by too rapid a decompression after exposure to high pressures for a period of time.

The author depicts in detail the engineering, clinical, and physicochemical aspects of compressed-air illness. Statistical data are used to show how essential slow decompressions are. New York State regulations are given as illustrations of the necessity of having short labor shifts and long rest periods for men working under high pressures. The paper is well illustrated and contains a considerable bibliography.—Philip Drinker.

DISCUSSION ON THE PATHOLOGICAL CHANGES PRODUCED IN SUBJECTS RENDERED UNCONSCIOUS BY ELECTRIC SHOCK. Abstracted from Proc. Roy. Soc. Med., 1922, 15, 45, in Med. Science, Oct., 1922, 7, No. 1, 88.—Legge said that it was necessary to find out whether the instructions for the treatment of persons suffering from electric shock issued under the Factory and Workshop Act were sufficient, in view of the knowledge acquired since the work of Prevost and Batelli in 1899. In 1918

Professor Boruttau attacked the apparent-death theory of Jellinek, using the statistics from the German factory inspectors' reports, which showed that artificial respiration was unsuccessful. Levy said that most observers agreed that currents of 1,200 volts and over, if passed from head to foot, did not affect the heart, but did affect it when passed through the thorax. The effect of shocks from a condensor was not cumulative, since a single shock would cause fibrillation if passed in at the exact moment of the cessation of the refractory period. He referred to the continuance of respirations after the heart had stopped beating. He believed spontaneous recovery in man was not uncommon but could not occur later than about two minutes after the onset of fibrillation. Massage of the heart was a certain means of restoring its action, but must be carried out within five minutes. If respiration were paralyzed without the heart being affected, then prolonged artificial respiration was indicated: as both heart and respiration might be affected, he advised artificial respiration on the remote chance of spontaneous recovery of the heart. He also spoke of disengaging a person from a live wire with the foot and not the hand. Spilsbury said that it was nearly always possible to determine the points of entry and exit of the current postmortem. He referred to the usual postmortem findings and gave suggestions as to the cause of death. MacWilliam said he had found two modes of immediate death: (1) arrest of respiration from paralysis while the heart continued to beat; (2) fibrillation of the ventricles. He referred to the relative frequency of these two types of death. He also advised artificial respiration in all cases and stated that massage of the heart was also of great use, especially if accompanied by the intravenous injection of drugs, several of which he mentioned, with the dose to be employed.

INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

The Measurement of Humidity. *Ezer Griffiths.* Abstracted from Beama, 1922, 11, 530-537, in Chem. Abstr., Nov. 10, 1922, 16, No. 21, 3573.—Griffiths investigated the various methods of measuring humidity in connection with a food research. His preliminary report is submitted. The full report will be published as Special Report 8, Nat. Phys. Lab., London. During the last one hundred years no fundamentally new method of hygrometry has come into general use. The psychrometer is well adapted in situations where there is a forced draft of air. The dew point apparatus has a sound theoretical foundation and can be easily manipulated at low temperature. It is the most convenient for use as a standard of reference. An improved Nat. Phys. Lab. form is described in detail. For everyday use the hair hygrometer is preferred as it is direct reading and simple in construction, although it is not as accurate as the other two types.

A New Dew-Point Tester. *W. Ostwald.* Abstracted from Ztschr. f. angew. Chem., 1922, 35, 443-444, in Chem. Abstr., Nov. 10, 1922, 16, No. 21, 3559.—The apparatus is based on the wet-and-dry bulb principle, the thermometer being a double instrument with two scales, one of which shows the temperature while the g. H_2O per cubic meter of gas is read directly from the other. Directions for operating are given.

A New Carbon Dioxide Recorder. Abstracted from Electrician, 1922, 89, 15, in Chem. Abstr., Oct. 20, 1922, 16, No. 20, 3415. —This article describes an electrical resistance meter depending upon the variation in thermal conductivity of the air with varying amounts of CO_2. A portable non-recording apparatus for quantitative analysis of CO_2 in air is also described.

New Apparatus for the Determination of the Carbon Dioxide of the Air. *H. Lundegardh.* Biochem. Ztschr., 1922, 131, 109-115.—This title is listed for the benefit of interested readers.

The Kata-Thermometer as a Measure of Ventilation. *L. Hill, H. M. Vernon* and

D. Hargood-Ash. Abstracted as follows from Proc. Roy. Soc., 1922, 93B, 198-206, in Chem. Abstr., Sept. 20, 1922, 16, No. 18, 3151-3152. —A study of the use of the dry kata-thermometer to measure wind velocity and temperature, and of the wet kata-thermometer to measure wind velocity, temperature, and evaporation.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

The Works Doctor in France. Lancet, Dec. 23, 1922, 203, No. 5182, 1344-1345.—This notice reviews an article by Prof. Etienne Martin in the *Journal de Médecine de Lyon*, in which is told how the French Ministry of Labor during the war took steps to install industrial physicians in most munition factories. The workers are now anxious to retain these medical services, and employers in large industries are looking upon the works doctor as a necessity, although not a legal obligation.

A summary is given of the services rendered and of the way in which close cooperation is effected between doctor and employer. University faculties of medicine are urged to undertake the training of physicians to be expert in industrial hygiene.—E. L. Collis.

Improved Medical Supervision in Factories. *W. F. Dearden.* Welfare Work, 1922, 3, No. 35.—This article is written to draw attention to the possibilities of cooperation between the welfare supervisor and the certifying surgeon. The section of the Factory Act dealing with the examination of young persons for certificates of fitness is criticized. It is pointed out how arrangements may be made between the employer and certifying factory surgeon and cooperation established between the welfare supervisor and the surgeon on such matters as the "following up" of young persons, and extension of the age limit for examinations, reexamination of adolescents, and first aid.—E. M. Hewitt.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

The Functions of the State in Enforcing Industrial Hygiene Legislation. *Francis D. Patterson.* U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2625-2630.—The logical, effective plan of Pennsylvania in making industrial regulations is first to call into consultation both employer and employee.

Industrial legislation should include provisions for: (1) care of the pregnant wage earner; (2) effective prevention of child labor; (3) seats for female employees; (4) hours of labor for female employees; (5) washing facilities at work places; (6) eating facilities; (7) plant cleanliness; (8) safe drinking water with exclusion of the common drinking cup; (9) ventilation and heating; and (10) prevention of vocational diseases. —B. Cohen.

Term "Injury" in Ohio Workmen's Compensation Law Construed. U. S. Pub. Health Ser., Pub. Health Rep., Oct. 20, 1922, 37, No. 42, 2646.—The supreme court of Ohio has decided that the term "injury" in the Workmen's Compensation Law does not include diseases contracted in the course of employment, and accordingly holds that death from typhoid fever is not compensable. The question of the compensability of occupational diseases was not involved in the case.—B. Cohen.

Majority Report of the Committee on Estimating Compensation for Eye Injuries. Jour. Am. Med. Assn., Nov. 25, 1922, 79, No. 22, 1843-1845.—This report deals with the computation of compensation for loss in visual efficiency resulting from eye injuries. It contains tables and illustrative cases indicating the method recommended of computing compensation.—K. R. Drinker.

ABSTRACT OF THE LITERATURE

OF

INDUSTRIAL HYGIENE

VOLUME IV APRIL, 1923 NUMBER 12

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GENERAL

PHYSICAL DEFECTS DISCOVERED IN SELECTIVE DRAFTS MEN DURING THE WORLD WAR. *Merritte W. Ireland.* Jour. Am. Med. Assn., Nov. 4, 1922, 79, No. 19, 1579-1581.—The more important physical causes of rejection of drafted men during the World War were: organic diseases of the heart, 11.5 per cent. of the total causes of rejections; tuberculosis, 9.3 per cent.; errors of refraction, 8.4 per cent.; underweight, 7.6 per cent.; mental deficiency, 4.5 per cent.; hernia, 4.3 per cent.; flatfoot, 3.6 per cent.; defective and deficient teeth, 3.2 per cent.; defective speech and hearing, 2.6 per cent.

Of the large class of diseases, the defects of the bones and organs of locomotion ranked first, with 17.2 per cent. of the total causes of rejections; diseases of the heart and blood vessels, second, 15 per cent.; diseases of the eye, third, 12.6 per cent.; and tuberculosis, fourth, 9.3 per cent.

Of the individual defects which were recorded most frequently in the men examined, the principal ones occurred in this order: flatfoot, 11.7 per cent.; venereal disease, 5.7 per cent.; hernia, 4 per cent.; refractive errors of the eye, 3.3 per cent.; organic disease of the heart, 3.1 per cent.; underweight, 3.1 per cent.; tuberculosis, 2.5 per cent.; hypertrophied tonsils, 2.3 per cent.; defective teeth, 1.4 per cent.; mental deficiencies, 1.2 per cent.—K. R. Drinker.

HEALTH HAZARDS IN INDUSTRY. *D. G. Robertson.* Ministry of Health, Commonwealth of Australia, Service Pub. No. 22, 1922.—This pamphlet usefully indicates the health hazards in industry, the occupations in which

they occur, and the signs and symptoms of ill health to which they give rise. It presents a readable digest of recent works on industrial hygiene. Attention is drawn to environmental influences, such as air stagnation, temperature and humidity, dust and fumes; the importance of infection from worker to worker; inadequate illumination; over-fatigue; abnormal attitudes and over-exercise of certain parts of the body.

The relation of industry to the spread of anthrax, hookworm, septic infections, and tuberculosis is pointed out; and modern views with regard to the occurrence and prevention of accidents are stated. The publication closes with a valuable and comprehensive table in which are summarized (1) each particular hazard, (2) the symptoms or condition of disease to look for, and (3) the occupations which offer the hazard. This document is important not only for itself but as being a landmark indicating how rapidly the science of industrial hygiene is spreading throughout the world.—E. L. Collis.

Some Factors Which Make for Efficiency and for the Social Uplifting of Industry. *Thomas Oliver.* Brit. Med. Jour., Aug. 26, 1922, 2, No. 3217, 374-377.—The fact that workers are physically affected by the trade which they follow raises the question as to whether they should periodically undergo medical examination. Dr. Oliver mentioned three points of view from which the subject could be approached: (1) the attitude of the workman concerning his rights, to which he would probably subordinate all questions concerning his health and his industrial future; (2) the attitude of the employer; and (3) the general medical aspect of the question. It was his opinion that the working men themselves would not accept medical examination on the lines which had hitherto been proposed, and that it would be difficult to make an examination compulsory, though in any particular factory it might be tried voluntarily as an experiment. Employers also might raise objections on the score of expense and temporary suspension or dislocation of work, though probably few would object to an entrance medical examination of apprentices, or to periodic repetition of examinations during the years of apprenticeship, since physical or other defects might be detected, and the youth given an opportunity of taking up another occupation. There would be advantages to the youths themselves if, after completing their apprenticeship and having attained the age of 18 or 19, they were medically examined and pronounced fit to remain in the employment. The physical breakdown in health of many young persons during the past years might have been due to the lack of repetition of the medical examination. In the case of the older employees, the examination might also show whether the individual was fit for the particular work, and whether the occupation was suiting him, for men and women cannot go on working for several years in succession without some structural changes occurring in the body, as indicated by a rise of blood pressure, or by impairment of the action of the heart—changes which dietetic and medicinal treatment accompanied by a respite from work might possibly correct.

In the face of such facts Dr. Oliver thought that there could be no serious objection to a medical examination of men who were taking up factory work for the first time, and to a record being kept of the results of such an examination. Though some sections of the labor party might not approve of this, there are certain trades in which a pre-occupation examination is already required. While admitting that, so far as taking on "datal" labor at the factory gate was concerned, an experienced foreman was a better judge of an applicant's special fitness for the particular kind of work than a doctor could be, Dr. Oliver considered that a careful medical examiner could be of assistance in occasionally detecting beneath the strong frame and the healthy appearance of the workman the existence of some serious disease. It may be objected that the medical examination, by preventing men from taking up certain trades, will increase the number of unemployed; but opposed to this is the fact that only the fittest men will be recommended to take up the harder trades and the less physically fit sent to those which are less arduous. Is it likely that labor will consent to such an assignment and distribution of applicants for work? Men are neither machines nor draft animals, nor is there the slightest reason why physical

fitness should be thus penalized. Quite apart from physical fitness the personality of the worker must be considered, and it must be remembered that his health is his capital.

Respecting the suggested reexamination of all young persons employed in factories at an age of 18 or 19 years, Dr. Oliver instanced the large number of deaths of female workers between the ages of 18 and 25. During the early years of employment in a factory young persons ought to be medically examined, since this is a vulnerable period, particularly of female life, as shown by the tables of the Metropolitan Life Insurance Company of America. During the last decade, an increase occurred in the number of deaths of girls between 15 and 20 years of age, while other age-periods showed a decrease; also there was an increase in the tuberculosis death rate amounting to 5 per cent. in adolescent girls, while the mortality rate from the same cause in boys of the same age decreased 25 per cent. He suggested that, if a medical examination of the workers were ever established in Great Britain, the health risks might be brought within the range of life insurance, and he instanced certain American experiences which supported such a scheme. He said that many persons believed to be quite healthy were found to have physical defects or diseases capable of cure or of being benefited. In women, for example, cancer in its early stages had been detected and removed, with the result that many of the women were alive today. One of the greatest stimuli to industrial efficiency was work; on the other hand, as causes of industrial inefficiency we could not overlook individual slackness, prolonged unemployment, and frequent strikes.—W. F. Dearden.

SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Cancer of the Scrotum: The Etiology, Clinical Features, and Treatment of the Disease. *A. H. Southam* and *S. R. Wilson.* Brit. Med. Jour., Nov. 18, 1922, 2, No. 3229, 971-973.—A strong doubt as to whether, under modern industrial conditions, the majority of cases of epithelioma of the scrotum are actually chimney sweep's cancer induced these two surgeons to study the records of the patients treated in the Manchester Royal Infirmary during the past twenty years (1902-1922).

The occupational incidence was shown to be as follows:

Mule spinners	69
Tar and paraffin workers	22
Sweeps	1
Various occupations	38
Occupations not stated	11
Total	141

These figures show that in South Lancashire the incidence of the disease is very pointedly associated with two important groups, the one most affected being workers engaged in the staple industry of cotton spinning; and further, that the local chimney sweeps must have taken seriously to habits of cleanliness.

The article contains nothing new respecting the incidence of cancer among tar and paraffin workers, but is of deep interest when it comes to deal with "mule" spinners. The fact that in a large proportion of the cases from cotton mills the growth was situated on the left anterior aspect of the scrotum, led the authors to investigate the exact significance of this feature. They find that the "minder" in "pieceing up" does this with his left hand, at the same time standing on his left leg with his right stretched out behind to counterbalance his reach over the mule carriage. On the carriage itself, about 3 feet from the floor, is a steel bar running the whole length, and this they found to be in a greasy state from the oil thrown off by the revolving spindles. The method of stance described has the effect of bringing the left groin and scrotum against the greasy bar every time the operation of piecing is carried out. The spinner works in a shirt and a pair of linen trousers, which are washed at the week-end; an inspection at this time shows a well-marked oil zone, 6 to 8 inches in depth, across the garment at a level corresponding to the upper part of the thighs and lower abdomen. The skin in this region is, therefore, constantly irritated by the oil, and itching and scratch-

ing result. The oil in general use is said to be a mineral oil of the paraffin series. An additional factor emphasized is that the spinner works in a hot and humid atmosphere and perspires freely. The authors ascribe the causation of irritation to friction of clothing, repeated traumatism of the body against the machine, and the continuous contact with mineral oil.

The lesion commences almost invariably with a solitary wart; this is on the left front in 83 per cent. of the cases, on the right front in 10 per cent., and on the mid line in 6 per cent. It would appear that this wart is cancerous from the beginning, as local removal is frequently followed, about twelve or eighteen months later, by malignant deposits in the groin. The warty stage persists for four to six months, the tumor varying in size from that of a sixpence to that of a half crown; after this period the typical ulceration commences. The rate of growth varies, but the average time from onset to coming into hospital was twelve months. Local spread is not rapid or extensive; in only six cases was the testicle involved, and in only three was the penis affected. Secondary infection of the inguinal glands is common, but in only one case did the growth spread to the peritoneum. Treatment consists in early removal of the growth, together with the lymphatic glands of both groins.—W. F. Dearden.

Experimental Tar Cancer. *H. T. Deelman.* Abstracted as follows from Nederl. Tijdschr. v. Geneesk., July 22, 1922, 2, No. 4, 334, in Jour. Am. Med. Assn., Nov. 4, 1922, 79, No. 19, 1649-1650.—Among the points emphasized by Deelman from his research on mice is that it takes a certain standard length of time for the benign proliferation of epithelium to occur in consequence of repeated application of tar. It develops cancer in time, but the interval before the cancer becomes manifest varies within a wide range. This suggests, he says, that the precancerous condition develops according to a regular process, but the development of cancer therefrom is dependent on more or less casual circumstances. The cancer seems further to have a multicellular beginning.

Tar Cancer in Mice (Le Cancer du Goudron chez la Souris). *G. Roussy, R. Leroux* and *E. Peyre.* Presse méd., Dec. 9, 1922, 1061-1065.—A summary is presented of research in which over 500 white mice were anointed with tar. Epitheliomata were produced similar to those described by Fibiger, Bang, Murray, and Leitch. The authors state that secondary growths were rare, and showed a predisposition to be localized in the lungs, which is unusual; they were unable to graft the epitheliomata produced on other mice. In one case the character of the growth was epitheliomatous on the surface, but sarcomatous deeper down. Attention is directed to one series of mice: 30 per cent. developed malignant tumors; 30 per cent. developed benign tumors; 10 per cent. developed tumors which appeared, but then regressed and disappeared; while 10 per cent. were completely refractory. Yet the mice were all of the same breeding, of the same age, often of the same litter, were living in the same cage, and were treated in the same way. These results point to the living soil (*facteur terrain*) playing an important part not yet understood. Attempts to modify the soil by food lacking in vitamines gave no definite results.—E. L. Collis.

The Effect of Cessation of the Irritant on the Development of Experimental Tar Cancer. *Archibald Leitch.* Brit. Med. Jour., Dec. 9, 1922, 2, No. 3232, 1101-1103.—This article by the director of the Cancer Hospital Research Institute (London), details certain experiments upon mice, which were made with a view of determining the effect on the development of cancer of the complete cessation of tar applications before signs of malignancy had developed. Clinical observations in human cases have shown that with removal of the irritant some warts disappear, some remain simple for many years, and presumably continue so indefinitely, and some warts progress to malignancy.

Discarding from consideration the case of one mouse which died and was eaten by its companions, the first series of investigations relates to fourteen mice, which, after from four to five months' local treatment with tar, exhibited small warts on the skin, all of which were definitely considered to be simple growths at this particular stage. The subsequent history shows that the papillomata dis-

appeared in five cases, remained as simple growths in three cases, and became malignant in six cases. The author makes these deductions: (1) that the production of the cancerous state is not necessarily the result of the action of the irritant on neoplastic as contrasted with pre-neoplastic tissues; (2) that the bias toward malignancy is given to the cells probably during the pre-neoplastic stage; and (3) that the successful transplantation of a tumor in the histologically doubtful stage is not a sure proof of malignancy of the tissue at that particular date, since the tumor, if left alone in its natural environment, will tend to declare itself as an epithelioma.

With a view to rendering these conclusions more certain a further series of experiments was undertaken; the essential condition being that in all the cases the irritant had been suspended before any neoplastic action had taken place. The mice were painted three times weekly for four or five months, and when this was stopped there were twenty mice with no visible sign of neoplastic reaction. Of these, six remained negative until they died, four developed temporary warts, four developed simple papillómata, and six developed malignant tumors.

These experiments clearly show that when tar has been applied repeatedly for a certain length of time, and the irritant is then removed, tumors, even carcinomata, may make their appearance at a later date. Undoubtedly the irritation produces in the normal cells subjected to its influence some profound change, undetectable by the microscope, so that they eventually proliferate in an unrestrained and harmful fashion. The author concludes that the neoplastic response to an irritant is a slow tissue reaction that exhibits no defensive property, that subserves no useful function. The internal changes in the cells in the earliest stages may some day be analyzed: at present they are quite unknown. In the skin epithelium we have a tissue which we have been taught to believe is constantly being shed and constantly regenerated, and one would imagine that the damaged cells would soon be shed, leaving a new and healthy race to take their place. Of course in man the processes take a much longer time to evolve.

We can discover the minimum duration of exposure to a tissue irritant necessary to produce cancers in mice, and thus form an idea of the length of the latent period before they are evident; it is possible that this will vary with different agents.—W. F. Dearden.

THE PRODUCTION OF CANCER BY SPECIFIC FORMS OF IRRITATION. *J. A. Murray.* Brit. Med. Jour., Dec. 9, 1922, 2, No. 3232, 1103-1104.—Discussing the artificial production of tar cancer in mice, the author refers to the opinion of Bloch and Dreyfuss that the active substance is contained in the anthracene fraction of coal-tar boiling at over 300° C. In his own experiments he finds that an extremely active extract can be prepared from tar by successive extractions with water, alcohol, and ether; the last is particularly effective. He applied unaltered tar, alcoholic extract, and ethereal extract to separate areas of the dorsal skin of each of sixty mice. After four months, when the first tumor appeared, fifty mice survived, and of these twenty-five presented new growths. Twenty-two of the latter bore carcinomata at the sites painted with ethereal extract, twelve at the sites treated with the original tar, and two only at the sites treated with the alcoholic extract.

Another series of experiments with tar was carried out on mice which had previously responded to tar applications in other situations. Up to the time of this report, no second initiation of cancer had been observed. Mice which had developed spontaneous mammary carcinoma had been similarly treated without success. These latter experiments seem to indicate that the previous existence of a cancerous growth may in some way hinder the production of a second primary tumor.—W. F. Dearden.

PARAFFIN CANCER AND ITS EXPERIMENTAL PRODUCTION. *Archibald Leitch.* Brit. Med. Jour., Dec. 9, 1922, 2, No. 3232, 1104-1106.—The author first summarizes certain interesting facts brought out by a study of historical cases occurring in the Scottish shale oil industry and in connection with German brown coal distillation. The subjects of his study have been long exposed to the action on the skin of crude mineral oils, and though the lesions are referred to as "paraffin cancers," it is by no means certain that the particular

harmful agent in the oils is a member of the paraffin series; both shale and German brown coal yield, in addition, a varied range of chemical derivatives. The workers in the refineries who deal with solid paraffin or with the more refined oils are not prone to dermatitis or cutaneous tumors. Whatever the chemistry of the substances may be, there is in crude paraffin oils something that induces neoplasia. The skin cancers that they produce are all of an exactly similar type; they occur on sites unusual for squamous carcinomata unassociated with definite forms of irritation; they are frequently multiple; they are generally preceded or accompanied by warts or other hyperplasias; they are often of a low degree of malignancy; it takes several years of exposure to the noxious substances before they develop—never less than ten years in the German industry and probably never less than fifteen in the Scottish oil works. Although the patients are usually of middle age or over, it is a question perhaps rather of the length of exposure than of the age of the individual. Can it be said that the substances under consideration are the actual cause of epitheliomata? The generally accepted opinion has been to regard them as mediate or predisposing rather than as proximate causes: they bring about such a pathological condition of the skin that the soil is rendered suitable for the operation of some other and hitherto mysterious cause. Though it is impossible to controvert such an idea, the author thinks that the success which has attended his efforts to produce cancer experimentally minimizes its cogency.

For the purpose of his experiments he obtained from a Scottish oil company supplies of four crude products known severally as "green oil," "blue oil," "unfinished gas oil," and "unfinished lubricating oil"—a series advancing in purity and representing in the order given a diminishing content of solid paraffin. Mice were used and painted between the shoulders three times a week for several months.

Green Oil.—This product is the first with which workmen come in contact. A series of 100 mice was used and after one hundred days only twenty-nine remained alive. Of the survivors sixteen never developed tumors, four exhibited small warts which subsequently disappeared, eight developed simple increasing papillomata, and one developed a malignant tumor. The mouse last mentioned showed advanced papilloma of doubtful character on the surface and a deeper growth which proved to be a spindle celled sarcoma.

Blue Oil.—Workmen at the presses are continually in contact with this oil. At the end of one hundred days twenty-two mice out of 100 used were alive, and of this number nine remained negative, one showed a temporary tumor, ten had increasing papillomata, and two developed malignant tumors. Of the latter, one mouse showed two distinct epitheliomatous growths and the other a spindle celled sarcoma infiltrating the deep muscles.

Unfinished Gas Oil.—Only one temporary tumor was obtained among thirteen mice which had survived the one hundred days.

Unfinished Lubricating Oil.—Three tumors were produced among ten mice which survived the one hundred days, one developing into a typical epithelioma.

The article gives details respecting the thirty mice which survived and reacted. Owing to the increase in death rate after the one hundred days, it was impossible to say how many would have developed tumors had they lived long enough, or how many of the simple growths would have become malignant. Certainly one animal resisted for over nine months. In many of the other papillomata Leitch experienced some difficulty in forming a judgment of their benignity or malignancy; the boundary line being nebulous, he adopted the convention of not reckoning a tumor as malignant, no matter how extensive the heterotopy of epithelium or the lack of differentiation of the cells unless the panniculus carnosus had been definitely penetrated. He did not use the method of transplantation as a criterion of malignancy because he did not believe that it gave any surer, or even additional, information on that point. The sections of the two sarcomata had been seen by several pathologists of distinction all of whom agreed with the diagnosis. Leitch expresses the opinion that the sarcomatous development, which in these two cases occurred underneath previously existing papillomata, was probably due to the entrance of the carcinogenic agent into the subcutaneous connective tissue through small fissures in the over-

lying epithelium. Sarcomatous formation has not been found in paraffin workers, but its observation in mice is of interest in that it demonstrates that the same causal agent may produce two such widely different kinds of malignant tumors as epithelioma and sarcoma. Leitch believes that the results of the experiments show that an actual causal agent, in contradistinction to a predisposing agent, was dealt with.—W. F. Dearden.

Epitheliomatous Ulceration in Industry. *T. M. Legge.* Brit. Med. Jour., Dec. 9, 1922, 2, No. 3232, 1110-1111.—The author explains the measures taken by the British Government to prevent the incidence of irritative cancer industrially and to secure prompt treatment when it does arise. When pitch cancer was scheduled as an industrial disease qualifying for compensation in 1907, its definition was widened to include causation by paraffin and mineral oil. After an inquiry in 1911, regulations were issued governing the manufacture of patent fuel with the addition of pitch other than blast furnace pitch. Blast furnace pitch had been excluded, as no evidence of the production of cancer from its use could be found and it was shown to be of different chemical composition from gas works pitch, containing neither naphthalene nor anthracene.

From 1911 to 1919 there was voluntary notification of cases of pitch warts and of cancers requiring treatment, and these were reported upon by certifying surgeons. Information was thus received of 158 attacks, with three deaths, among pitch workers; twelve, with two deaths, among tar workers; and twelve among workers in the shale oil industry.

In January, 1920, epitheliomatous ulceration occurring industrially was, by order of the Secretary of State, added to the list of notifiable occupational diseases and poisonings. Preceding June 30 of the current year, ninety-five attacks had been notified and investigated, sixty-six being among pitch workers, twenty-one among tar workers, and eight among paraffin workers. The actual number affected was eighty-nine, there being single recurrence in four cases and double recurrence in one case. Fifty-eight of the sufferers were between 40 and 60 years of age; twenty-seven had worked from twenty to thirty years, and seventeen between thirty and forty years at their employment; the scrotum, face, forearms and hands were the main sites of the disease. A table is given stating the specific occupations of those affected. The total number engaged in the patent fuel industry is given at 2,500, but the number in the tar-distilling industry is not yet known. The number engaged in paraffin refineries of shale oil works is 200, but the number of retort men is not available.

In 1919 the trade unions in South Wales asked for voluntary medical examinations in order to prevent pitch warts from becoming inoperable; this was arranged for those over 30 years of age, who had been employed over ten years (this included about 20 per cent. of the workers). It is now possible for any workman to consult Dr. Scholberg, the pathologist of the Cardiff Royal Infirmary, or Dr. Sladden of the Swansea Infirmary.

No case of aniline tumors of the bladder had been reported. Although since January, 1920, 175 cases of chrome ulceration had been notified, in none of these was there any suggestion of epithelioma.—W. F. Dearden.

RESPIRATORY SYSTEM

Acute Suffocative Edema of Lungs. *W. J. Tyson.* Abstracted as follows from Lancet, Oct. 21, 1922, 203, No. 5173, 859, in Jour. Am. Med. Assn., Nov. 25, 1922, 79, No. 22, 1882.—Tyson asserts that these are really cases of aborted pneumonia, in which the congestive stage is fully developed and then the disease stops, being relieved by the escape of the collected serum, to end either in rapid recovery or in rapid death. The consolidation of the lung is not often demonstrated, but the signs of acute congestion are present. In his case, which is cited, only one lung was attacked, and herpes on the lips was present, both symptoms suggesting a pneumonic origin. Influenza seems to favor this condition, being the starting point of the pneumonia in two or three cases recorded—in Tyson's case an influenza epidemic was present in the district where the patient lived. Immediate venesection is the treatment generally recommended, together with outward applications, such as wet cupping and mustard plasters. Morphin, iodids, or blisters should not be used in the treatment of these cases, for obvious reasons.

POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Carbon Monoxid Poisoning. *M. Nicloux.* Abstracted as follows from Méd., Sept., 1922, 3, No. 12, 913, in Jour. Am. Med. Assn., Nov. 11, 1922, 79, No. 20, 1722.—Nicloux reiterates that the blood corpuscle is not injured irreparably by carbon monoxide displacing the oxygen in the hemoglobin, provided oxygen can be supplied promptly to drive out the carbon monoxide in turn. The corpuscle asks nothing better than to resume its normal functioning with oxygen.

Dangers of Phosphoric and Hydrocyanic Acid Vapors. Jour. Am. Med. Assn., Nov. 25, 1922, 79, No. 22, 1863.—Dr. Schnellen, medical adviser in a large match factory, made experiments on animals with the vapors of phosphoric acid and hydrocyanic acid, with findings in perfect accord with those of Wayschall, Yanote and Lehmann. Hydrocyanic acid, when given in the strength of from 0.03 to 0.04 per cent., has no effect on cats after three or four hours' exposure. As soon as the strength of the vapor is raised to 0.05, and the animal is immersed in it for an hour and a half, grave symptoms appear, such as deep respiration, increased salivation, dilatation of the pupils, cramp and vomiting. If the animal is kept in this atmosphere for from two and a half to five hours, death ensues. If the strength of the vapor is raised to 0.12 or 0.15 per cent., death occurs within thirty minutes, accompanied by the foregoing symptoms. In calculating the amount of hydrocyanic acid necessary to destroy life, the dose is found to vary from 1 mg. of the acid to 5 mg. for each kilogram of body-weight of the animal. For man, it is calculated that 60 mg., or from 0.8 to 1 mg. for each kilogram of the body-weight, would be a minimal lethal dose.

For phosphoric acid, it is found that doses of from 0.6 to 0.4 per cent. for a quarter of an hour render the animal quiet (Lehmann's experiments). After twenty minutes' immersion, the saliva is emitted from the mouth, with vomiting, and feebleness and unsteady movements are noted. An immersion lasting half an hour causes death. If the animal is allowed to remain fifteen minutes in the saturated receptacle, it requires two days in the open air to recover.

The Toxicity of Tetrachlorethane. *Frois.* Rev. d'hyg., Nov., 1922, 44, No. 11, 987-992.—The author comments briefly upon the value of the following substances as industrial solvents: carbon tetrachloride, dichlorethylene, trichlorethylene, tetrachlorethylene, tetrachlorethane, and pentachlorethane. Because of their noncombustible character they may be used to advantage in the place of benzine and carbon disulphide.

He states that carbon tetrachloride in a concentration of 1.5 gm. per hundred liters of air induces narcosis, headaches, and vomiting. It attacks copper and zinc in a humid atmosphere.

Tetrachlorethane is the best solvent for cellulose acetate and it has extensive uses in the manufacture of varnishes and colors and of lacquer; in the rubber industry; in the extraction of certain alkaloids and of oils; and in lithography and numerous other processes. He recalls the cases of poisoning from tetrachlorethane which occurred during the war in connection with the use of the chemical in the varnish for aeroplane wings, but reports that no fatalities resulted in France. One death occurred in the case of a girl employed in the manufacture of gas masks, using as cement a solution of cellulose acetate dissolved in tetrachlorethane mixed with alcohol denatured with acetone.

Three deaths more recently occurred among workmen engaged in the manufacture of artificial pearls, which in some establishments are coated with a solution of fish scales in tetrachlorethane. Though the exact cause of the fatalities was not legally determined, the reports of severe jaundice led the author to believe that they were produced by tetrachlorethane, especially that evaporated from the pearls in the course of drying.

He mentions as the initial symptoms of poisoning headache, dizziness, and vomiting. There is variation in susceptibility, but workers affected even slightly seem as a rule to have severe attacks if they are again exposed to the toxic agent. The vapors affect the nerve centers and the liver. There are no changes in the blood such as those observed in cases of jaundice produced by nitro derivatives of benzene and toluene.

In the author's opinion general measures to promote good ventilation of the workroom are insufficient and tetrachlorethane fumes should be removed by exhaust near the points at which they are liberated. He suggests the use of a cage with glass top and front, with holes for the arms of the worker. Downward exhaust, maintained at low pressure would remove the fumes without causing too rapid evaporation of the solvent with consequent chilling of the hands of the operator and injury to the pearls.—Wade Wright.

Methane in Steel Cylinders. *J. Bronn.* Zentralbl. f. Gewerbehyg., June, 1922, 10, No. 6, 158-159.—Dr. Bronn discusses a new process for compressing methane into steel cylinders under 150 atmospheres, which permits transportation for industrial uses. On account of slow combustion in gas burners, the flame tends to go out, but, if protected, high temperatures can be reached. Methane oxygen flame is used in welding copper, brass, and aluminum; methane is also used for making methyl chloride, methyl alcohol, and formaldehyde. It is produced commercially by coking of coal.

Lehmann considers it only slightly toxic. Air and methane mixtures, especially with 9 to 10 per cent. of methane, are explosive. In the presence of dust, a mixture of 3 per cent. methane in air is explosive.—J. W. S. Brady.

Lead Poisoning. Jour. Am. Med. Assn., Nov. 25, 1922, 79, No. 22, 1861-1862.—At a recent meeting of the Academy of Medicine, Herman touched upon the problem of the use of white lead. He regards air-borne lead poisoning as probable. These conclusions are based upon (1) the presence of lead in a disk of filter paper placed in a drier above a layer of white-lead paint, and (2) the lead reaction, secured seventeen times out of twenty with slips of filter paper suspended at various heights in a room freshly painted with white lead. Herman stated that a current of air may carry extremely minute particles of lead products, even after remaining a long time in a given spot. To intercept these minute particles, it is necessary to interpose a tampon of cotton, which retains them in the felt of its fibers, where their presence can be shown by chemical analysis. A practical conclusion of the highest importance is therefore imperative: During the use of white lead paints, microscopic droplets containing lead are produced. These remain suspended in the air sufficiently long to allow them to penetrate the respiratory passages (mouth and nose) of the workmen.—K. R. Drinker.

Studies of Chronic Intoxication on Albino Rats. VI. Lead Carbonate. *T. Sollmann.* Abstracted as follows from Jour. Pharmacol. and Exper. Therap., 1922, 19, 375, in Med. Science, Nov., 1922, 7, No. 2, 168-169. —The author gives a short summary of what is known with regard to lead poisoning in man and in animals. The amount necessary to produce intoxication in man is from 0.2 to 0.3 mg. per kilo. The amount is much higher for animals. The experimental work was done on rats. Amounts from 0.0007 to 0.15 mg. per kilo produced slight but definite check of growth and appetite. The mortality of these rats was high between nine and seventeen weeks, owing probably to lowered resistance. The whole dose of lead in clinical human plumbism probably begins with one-fifth to one-third grain per kilo; but it is seen that much smaller doses are not harmless to rats, and it is pointed out that in cases of metallic poisoning there is probably a wide gap between the amounts which will produce definitely poisonous symptoms and those which are completely harmless.

Urinary Porphyrin in Lead Poisoning. *O. Schumm.* Abstracted as follows from Ztschr. f. physiol. Chem., 1922, 119, 139, in Med. Science, Nov., 1922, 7, No. 2, 168.—The spectroscopic and physical properties of the porphyrin excreted in the urine in cases of lead poisoning show that it has the characteristics of fecal porphyrin and not of true urinary porphyrin, the latter not being present in detectable amounts. If this be the case it follows that the porphyrinuria of lead poisoning is not identical with that due to veronal.

The Risks of Plumbism in Pottery and China Manufacture in Sweden. Abstracted from Kungl. Socialstyrelsen, Stockholm, 1922, pp. 28, in Internat. Labour Rev., Sept., 1922, 6, No. 3, 455-456.—This is the report of an

investigation of lead poisoning in the pottery and china trades in Sweden. During the last few years conditions have improved because of the substitution of insoluble silicate of lead for lead oxide in the glaze used in manufacture. Out of seventy-one persons examined only one definite case of poisoning was proved, another had definite chronic symptoms, and 42 per cent. of those examined had slight symptoms which were possibly referable to lead. Thirty-three per cent. had basophilic granules in the blood in a proportion of over 300 to the million.—J. C. Aub.

The Method of Blood Examination in Lead Poisoning. *G. Seiffert.* München. med. Wchnschr., Nov. 17, 1922, 69, No. 46, 1595-1596.—This is a reply to the criticism of Engel upon the author's method of staining for stippling in unfixed blood smears. Seiffert maintains that blood smears which are dried in air and then stained with methylene blue, without first fixing in alcohol, make the search for stippling easier than in fixed smears. The number of stippled cells is larger. The only difficulty comes in distinguishing reticulated cells which have fainter granules not uniformly distributed through the cell.

A few stippled cells may be found in bloods of persons not exposed to lead.—J. C. Aub.

Saturnine Asthma: Is There Such a Malady? *Thomas Oliver.* Lancet, Oct. 28, 1922, 203, No. 5174, 907-909.—The question as to whether there is such a malady as saturnine asthma is discussed. A case of asthma is quoted wherein the patient had been in the habit of using occasionally a hair-wash which contained lead in considerable quantity. A trace of lead was also found in the urine, and the blood contained a few punctate basophilia. The asthmatic attacks improved whenever the use of the hair-wash was discontinued. The patient, as might be expected, showed a marked intolerance for iodide of potassium. The patient also suffered from phthisis, from which he finally died. After discussing the literature of recorded cases and pointing out that saturnine asthma in a lead worker is extremely rare, the author states that the relation of plumbism and asthma is not clear.—E. L. Collis.

DUST HAZARDS AND THEIR EFFECTS

The Efficiency of the Palmer Apparatus for Explosive Carbonaceous Dusts. *L. J. Trostel.* Jour. Am. Soc. Heating and Ventil. Eng., Dec., 1922, 28, No. 9, 853-858.—The Palmer apparatus was tested against elevator dust, corn starch, wheat flour, smut spores, ground oat hulls, ground sulphur, sugar, cocoa, ground rubber, and wood flour. All of the above dusts showed particles of sizes ranging from 5 to 150 microns. All were dried to constant weight and only the portions passing through a hundred mesh screen were used. Samples were introduced into the Palmer apparatus by rapping a tube, the end of which was covered with a bolting cloth to serve as a screen, as it was found impossible to float uniform dust clouds of particles of this size by air currents. The average efficiency of the Palmer apparatus for all of the above dusts was found to be 98.2 per cent. at speeds of 3 to 5 cubic feet per minute. The author's results indicate that the efficiency of the apparatus increases slightly with the size of the samples.—Philip Drinker.

Silicosis and Miners' Phthisis. *W. E. Gye* and *E. H. Kettle.* Brit. Jour. Exper. Pathol., Oct., 1922, 3, No. 5, 241.—Insoluble silica and silica sol, injected subcutaneously, cause a similar and characteristic lesion consisting of a central area of necrosis surrounded by a zone of leucocytes; around this again is a second annular zone of necrosis limited by macrophages and granulation tissue. Tubercle bacilli proliferate rapidly in the necrotic areas, a small dose of bacilli becoming a large dose. In this way silica aids in establishing a local infection.

1. The Anti-Bactericidal Properties of Colloidal Silica. 2. Agglutination of Washed Red Blood Corpuscles by Colloidal Silica. *S. L. Cummins.* Brit. Jour. Exper. Path., Oct., 1922, 3, No. 5, 237-240; 260-262. 1. The relation of cause and effect existing between the inhalation of silica dust and the occurrence of pulmonary silicosis in certain industries gives interest to research which discloses

the biochemical properties of silica. Blood serum is able to destroy typhoid bacilli, but the addition of colloidal silica was found to preserve the bacteria from the action of the blood. Similarly hemolysis of sensitized red blood cells was inhibited by colloidal silica. Cummins concludes that: (1) Colloidal silica has the property of interfering with the bactericidal power of blood in marked degree. (2) It inhibits the action of "complement" in a hemolytic mixture. This anti-complementary property is probably the character to which it owes its antibactericidal power. (3) These properties, together with the lack of any demonstrable germicidal power, point to colloidal silica as likely to be of great use in blood cultures in cases of bacteriemia.

2. Colloidal silica solution to which sufficient salt has been added to bring the mixture up to 0.75 per cent. of salt brings about rapid agglutination of washed red blood corpuscles and this result can still be obtained after considerable dilution.

The flocculation and sedimentation of washed red cells by colloidal silica is to a great extent prevented by the presence of concentrated human serum, this inhibition disappearing as the serum is made more dilute. The inhibition seems to depend upon the formation of a gel.—E. L. Collis.

OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

The Position of the Colony in the Tuberculosis Campaign. *S. Tinker.* Tubercle, Dec., 1922, 4, No. 3.—The author maintains that the municipal workshop offers opportunities for protected labor in a large number of cases, but that in rural areas a co-operative system of marketing the goods made by patients at home is essential. He considers that village settlement is too expensive a method of dealing with a large number of cases, but holds that industrial colony life reestablishes the mental as well as the physical well-being of patients, fostering initiative, and bringing the men out of the hopeless attitude which unemployment causes, and that although initial results may be small, they will increase with time and experience.—E. L. Collis.

Critical Reviews. Tubercle, Dec., 1922, 4, No. 3.—The first review deals with the value of industry in the treatment of tuberculosis. Papers published by E. Troy, Chicago, by H. R. M. Landis, The Phipps Institute, by P. C. Varrier-Jones, Papworth Settlement, and by A. S. McGregor, Glasgow, are brought under review, and the conclusion is drawn that suitable occupation is of great value to the tuberculous convalescent; it improves his mental outlook and reduces the cost of treatment. Nevertheless, the worst features of industrial settlements are their cost; but it is safe to prophesy that they will survive if the good which they do is worth doing.

The second review deals with the harm that some industries exert in causing tuberculous silicosis. Recent laboratory research is brought under review, and the way in which it is confirming deductions drawn from epidemiological inquiry is stressed. In particular, reference is made to the work carried out by Mavrogordato in South Africa, by Gye and Kettle, National Institute of Medical Research, and by Cummins, Welsh National School of Medicine. Each has been attacking the problem from a different point of view, but each finds that silica possesses certain definite properties not previously suspected and not manifested by other dusts investigated.

Finding and Caring for the Tuberculous Employee. *James A. Britton.* Nation's Health, Nov. 15, 1922, 4, No. 11, 676-677.—Any plan for supervising the health of a group of employees must carry with it some plan of adequate care of those found suffering from disease. Almost any plan of health conservation may be accomplished without too much risk by smaller industries as well as by large industries if they are willing to pool their health interests. Whatever plan may be adopted for the cure, prevention, or detection of tuberculosis by the industries, it should be only a part of some comprehensive health supervision scheme.—L. A. Shaw.

Helping T. B. Workers to Come Back. *James A. Britton.* Hosp. Management, Nov.,

1922, 14, No. 5, 70-71.—Intensive study of working conditions during the last ten years has brought out the fact that in most cases it is best for the man who has had tuberculosis to return to his old work rather than try to learn some supposedly less dangerous occupation. In cases that are recognized early through routine physical examinations men can often remain at work under proper supervision or resume it after a short rest period. In moderately advanced cases, 60 per cent. can be returned to work after six to eight months of care, preferably in a sanatorium. Two thirds of these will probably be able to resume their former places, while the remainder will have to be trained for less exacting work. In advanced cases, a high rate of permanent disability—that is, 80 to 90 per cent.—is to be expected. The keeping of the early cases "on the job" involves great care on the part of the physician and of the persons affected. Reeducation of the tuberculous is recommended only in exceptional cases.

A table is given showing that out of every hundred cases coming to the attention of the average industrial physician, ten are incipient, seventy-five moderate and fifteen far advanced. Figures are given showing that of the first group all but one could return to the old work after treatment; of the second group, thirty-five; and of the third, one. It is emphasized that keeping them on through proper health supervision is much better than getting them back after the disease is contracted.—G. N. Thompson.

An Experiment in the Employment of Arrested Cases of Pulmonary Tuberculosis. *H. R. M. Landis.* Am. Rev. Tuberc., June, 1922, 6, No. 4, 253-264.—The possibility of utilizing arrested cases of tuberculosis in some form of industry that would make them altogether or in part self-supporting suggested itself in 1911. During that year a night tuberculosis class was conducted at the Phipps Institute for patients who had recovered from their acute tuberculous symptoms under dispensary or class treatment, and for returned sanatorium patients.

1. This venture has shown that arrested cases of tuberculosis can be employed to advantage without detriment to their health, if properly supervised medically.

2. It is necessary to delegate to a business man the entire management of the commercial side of the problem.

3. From the economic side the experiment was a success. The deficit was small.

Anthrax in the Woolen Industry, and the Disinfection of Wool. *G. Abt.* Rev. d'hyg., 1922, 44, No. 4, 305-327; No. 5, 408-432.—This article is a discussion of the incidence of human anthrax in France, England, the United States, and certain other countries. It deals particularly with the handling of wool and with the need for disinfection of suspected raw wools.

The article is essentially a review of the report of the British Departmental Committee on Anthrax published in 1918 (1), of a memorandum published in 1921 on the disinfecting station for wool and hair established in Liverpool (2), and of certain data published in France.

Recognizing the difficulty, indeed the impossibility, of controlling human anthrax through the institution of necessarily elaborate regulations in industry, the British committee considered the proposals of suggested action in the countries of origin of infected materials, and disinfection of wool and hair. It was the belief of the committee that action in countries of origin was impracticable at the present time, certainly in Asia.

The committee was obliged to face the fact that, in spite of existing regulations concerning the personal hygiene of operatives and the safeguarding of hazardous trade processes, cases of anthrax were appearing with increasing frequency. Furthermore, a relatively small proportion of the cases developed among operatives employed at processes covered by the regulations. The subject of disinfection was then considered and a method devised by a sub-committee (the Duckering method) was recommended. A description of the various stages of this method is included. Selected varieties of wool subjected to the disinfection process were converted into fabrics with little or no evidence of important changes having taken place in the wool as a result of the treatment that it had undergone.

Dr. Abt discusses the advisability of disinfection of various wools in the countries of

their origin. He affirms the belief of the British commission that dangerous materials should be disinfected at the earliest possible stage. Until such action is possible the commission urged the establishment of a disinfecting station in England.

The author presents the experience of various European countries and of the United States, indicating that cases of industrial anthrax resulting from the handling of wool have been comparatively rare. He concludes his article with a consideration of the importance of careful study of the question of anthrax in the wool industry from an international point of view and from that of the French nation.—Wade Wright.

Bibliography

1. Report of the Departmental Committee Appointed to Inquire as to Precautions for Preventing Danger of Infection from Anthrax in the Manipulation of Wool, Goat Hair, and Camel Hair. Vol. I, Report of the Disinfection Sub-Committee (Cd. 9057). Vol. II, Report of the Committee; Summary of Evidence; Appendices (Cd. 9172). London, H. M. Stationery Office, 1918.
2. Prevention of Anthrax among Industrial Workers. Memorandum on the Disinfecting Station Established in Great Britain for Disinfection of Wool and Hair. London, H. M. Stationery Office, 1921.

OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Discussion on Occupational Dermatitis. *W. J. O'Donovan.* Brit. Med. Jour., Sept. 16, 1922, 2, No. 3220, 499-504.—In the opening paper read at the Annual Meeting of the British Medical Association, it was pointed out that the study of occupational dermatoses was particularly the province of the preventive physician. Cause and effect can usually be directly demonstrated.

When their etiology is known diseases are generally easy to comprehend, and fall into natural groups. Unfortunately the medical literature of traumatic dermatoses consists largely of the reports of a huge number of isolated, unconnected eruptions. These arise from a multitude of old or new chemicals often hidden under trade or fancy names which require interpretation by an expert chemist. Furthermore some writers report these skin diseases under occupation, industry, or process. The names and methods of these alter and change in course of time and the agent employed may be ill defined, not mentioned, unknown, and in some cases incorrectly stated.

The absence of any accepted classification in this branch of dermatology is one of its greatest drawbacks. Every teacher and student feels this to be an urgent need. Dr. Legge tentatively suggested four groups: chemical substances, like potassium bichromate, arsenious acid, and certain finished dyes; substances which soften and macerate the tissues, such as alkalies; substances which remove the natural grease from the skin, such as turpentine, petroleum, benzine, benzene and its homologues, and their nitro and amido derivatives; and processes which mechanically injure the continuity of the skin, such as brushing, scratching, and rubbing. With the exception of the first, all these groups are arranged according to their selective activity upon the skin. If possible the divisions should be based on a single principle which can be maintained throughout the series. One might add to Dr. Legge's scheme the large group of hygroscopic substances, such as strong sulphuric, hydrochloric, and phosphoric acids, potash, soda, lime, and, because of its content of magnesium chloride, common salt. Oxidizers form a compact group and include chromic acid, potassium permanganate, chlorine, nitric acid, nitrate of ammonium, etc. Many of the substances mentioned above belong in more than one category and further groups and sub-grouping will be found necessary to formulate a complete list.

O'Donovan stressed the importance of carefully watching for any cases of personal susceptibility when a new industry having a particular health hazard is being established. He finds that a largely immune body of workers can be secured by eliminating persistently, at the first onset of symptoms, every individual showing signs of intolerance. He described the case of a man who, after a week's work of staining wood with potassium bichromate, was prevented from working, because of the inflamed and ulcerated condition of his hand. The man stated that his master had dismissed twelve men in the last three

months for the same misfortune. O'Donovan remarks that this sounds ruthless but may, on occasion, be necessary. Later he mentions certain trades where complete protection against the irritant can only be assured when all hand contact is eliminated. One may perhaps venture the remark that the bichromates are often used to color woods without causing injury to workers. If these twelve men had used a different method of applying the stain, this wholesale discharge of workmen might possibly have been avoided.

The chief theme of Dr. O'Donovan's address was the description of an extensive series of cases of trade dermatoses, some of which are rare. The London Hospital is fortunately situated for the collection of such material.

Palmar keratosis is a common industrial complaint set up by the local intermittent pressure of the tool handled. A case is mentioned which occurred in a painter from grasping the handle of his scraper, and another in a woman who repaired boots, resulting from the constant friction of her hammer. In both instances the hard and thickened skin became inflamed from secondary infection, and healing was tedious. An exceptional case is recorded of a wart developing on the middle joint of the left thumb of a baker. He attributed this to the rubbing of the part, in his daily work, by a long and hot poker. When excised the growth turned out to be a squamous celled carcinoma. A cancer developed on the tongue of a boot repairer. He was in the habit of holding a supply of iron or brass rivets in the right side of his mouth, and, as he required one, moving it with his tongue to his lips.

Contrary to his expectations, the author finds that even very dirty work does not particularly predispose toward dermatoses. Prolonged contact with water, on the other hand, is always a real hazard. Numerous cases are cited in fishmongers, cleaners of enamel advertisements, washers of jam pots, scrubbers, etc. Dermatites occurring in dry cleaners and girls who paint golf balls are described and illustrated. Here the injurious agents are naphtha, benzine, or other substitutes of a like nature.

Eight men engaged in "shovelling up" dried figs, to be made into jam, are reported as suffering from the irritation caused by the carpoglyphus passularum. This parasite was found on the dry fruit. O'Donovan thinks that this is the first recorded instance of this organism producing an occupational rash. He has seen only one example each of bakers' and sugar workers' itch, a fact which is interesting and important because the former seems to be somewhat prevalent in this country. Paper which is sent abroad is almost invariably treated with a solution of formalin in water and glycerine. A number of girls conducting this operation showed an extraordinary sensitiveness of the skin to this agent; the resulting lesions were difficult to heal.

Oil rashes and folliculitis receive much attention in O'Donovan's remarks. He thinks that when boils and onychias are rife and troublesome to cure, the occupational risk of exposure to oil should always receive close consideration. Like all who are familiar with these common dermatoses, he regards adequate washing arrangements essential for their prevention. Tinea circinata may occasionally be communicated from hides when they are being unloaded from a ship. In the particular instance mentioned, the ringed, reddish eruption at the base of the left thumb was mistaken for anthrax. In another case the fungus was found in a barber engaged in the active practice of his art. He was known to have been suffering from ringworm many years.

The lesions which result from the prolonged handling of tar pitch, etc., were fully considered. Dr. O'Donovan has seen tar cancer develop in workers engaged in pickling telegraph poles, tar distilling, pickling sleepers in creosote, and gas works stoking, and also in an anthracene laborer, a chemical factory laborer, a gas works laborer, a pitch bed breaker, a barge loader, and a road sprayer. He further adds that tar cancer, as far as present knowledge goes, is not preventable but should not kill.

Fur sewers, fur dyers, and fur dealers, particularly young workers, are subject to skin eruptions.

At the close of the paper the question of treatment was discussed.—R. P. White.

Bacteriologic Study of Cutting Oils Causing Skin Lesions. *R. C. Rosenberger.* Abstracted as follows from New York Med.

Jour. and Med. Rec., Oct. 4, 1922, 116, No. 7, 377, in Jour. Am. Med. Assn., Nov. 4, 1922, 79, No. 19, 1639.—It is a very common thing to observe in those workers in or with oil a condition, either of an acne, a dermatitis or furunculosis. Various factors have been put forward as the causative agent in these conditions. Some have mentioned the irritating properties of the higher paraffin, others have mentioned the presence of the particles of metals, while all mention the personal cleanliness of the workers. Rosenberger asserts that the presence of staphylococci or streptococci in fresh or used oil is exceedingly rare, and, therefore, the alleged presence of these organisms in freshly made oils should not be accepted as the whole cause of the conditions cited. The addition of antiseptics or germicides to the cutting oils appears to exercise very little, if any, action on pyogenic bacteria in pus, nor is it effective in the prevention of infections of the skin.

Dermatitis from Substitutes for Turpentine. *Galewsky.* Abstracted as follows from Dermat. Wchnschr., March 25, 1922, 74, 273, in Arch. Dermat. and Syph., Nov., 1922, 6, No. 5, 638.—Four cases of occupational dermatitis in painters due to the use of substitute products for turpentine are reported. There were no unusual features in the eruptions.

Eye Affections in Motion Picture Actors. Jour. Am. Med. Assn., Nov. 4, 1922, 79, No. 19, 1623.—Professor Adam of Berlin spoke recently at the ophthalmologic congress in Jena on eye affections in motion picture actors. The observed disturbances consisted of inflammatory manifestations, reddening and swelling of the lids and a more or less marked sensitiveness of the eye. Adam ascribes these disturbances to an affection of the conjunctiva. The characteristic feature of motion picture conjunctivitis is that, in addition to the inflammation, small granular nodules appear. This gives rise to the assumption that this complication is due not only to the intense light radiation, but also to the effect of the dust on the conjunctiva.—K. R. Drinker.

Eyestrain in Industrial Occupations. *Nelson M. Black.* Nation's Health, Nov. 15, 1922, 4, No. 11, 682-684.—The author discusses the causes of defective vision and of eyestrain, and emphasizes the general impairment of efficiency which results from substandard vision. He goes on to discuss the importance of examining the eyes of all applicants for employment in order that visual defects may be discovered and corrected—a measure which protects the employer in case of accident, and which improves the health and efficiency of the workers.—K. R. Drinker.

Difficult Cases of Coal-Miners' Nystagmus. *T. Lister Llewellyn.* Trans. Ophth. Soc., 1922, 42, 315-319.—Accurate diagnosis of nystagmus among miners is important since the disease entitles one to compensation. Symptoms may be predominantly either atonic, spastic, or psychic. Diagnosis is easy only for atonic cases which are distinguished by manifest rotatory oscillation of the eyeballs. Diagnosis of the disease should not be made from the history given by the patient unless there is confirmation by physical examination. Rotatory oscillation of the eyes; true lid-spasm associated with photophobia; head tremor with backward inclination and resistance of the head, combined with objective giddiness, may separately be considered sufficient to confirm the diagnosis when accompanied by a typical history. Irregular movements of the eyes, rolling about of the eyes, blinking, may all be purposive. Miners may develop psychoneuroses quite apart from their underground life, and may refer their symptoms to the oculomotor apparatus. Pit work may not be the cause of incapacity. Objective signs of the disease must be present before a certificate of incapacity is given; otherwise a surgeon will only confirm the man in a neurosis and do him unintentional injury.—E. L. Collis.

Battery Burns: Report of Three Cases. *Harry S. Gradle.* Jour. Am. Med. Assn., Nov. 25, 1922, 79, No. 22, 1819-1821.—The author reports three cases of burns of the eye and adnexa by sulphuric acid from storage batteries. All of the patients were mechanics working on the storage batteries of automobiles. The accidents resulted from the ignition, by an electric spark in one case, and by

a blow-torch in two cases, of a mixture of hydrogen and air in the small air chamber that lies within the battery cell between the upper level of the sulphuric acid and the cover of the cell. The explosions resulted in the splashing of hot acid into the eyes of the patients.

The author advises the use of protective goggles by every mechanic who works with charging batteries, and outlines the first-aid treatment to be given in case of an accident of the type reported.—K. R. Drinker.

INDUSTRIAL SURGERY

An Emergency Universal Splint for Fractured Long Bones. *H. C. Masland.* Jour. Am. Med. Assn., Nov. 25, 1922, 79, No. 22, 1839.—The author describes with illustrations an emergency splint for use in factories, mines, patrol wagons, etc., to give comfort during the delay that occurs while a patient is being transported to a hospital for corrective treatment.—K. R. Drinker.

INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

A Teaching Device for Fatigue Elimination. *Frank B. Gilbreth.* Nation's Health, Nov. 15, 1922, 4, No. 11, 672-673.—By means of a device called the "Magster", which is an inexpensive stereoscopic viewer of magazine rolls of moving picture photographs on paper of time and motions, it is now possible to present to the apprentices and workers of the world, the chance to see the methods of the best workers available, in their chosen life work. This is a step toward automaticity in method of the best way to do a given piece of work.—L. A. Shaw.

Great Britain's Place in Fatigue Elimination. *Henry J. Spooner.* Nation's Health, Nov. 15, 1922, 4, No. 11, 673-676.—The first steps in the direction of a systematic study of industrial fatigue in Great Britain were taken in 1913 by the Home Office. With the outbreak of the war there came into existence the Health of Munition Workers' Committee under the Minister of Munitions. This committee was disbanded at the end of 1917 and its place taken by the Medical Research Committee and the Department of Scientific and Industrial Research. With the institution of drastic governmental economies in 1920 to 1921 the Industrial Fatigue Research Board was compelled to carry on its investigations on a more restricted scale than previously. Mention is made of the personnel of the various foregoing government agencies and of the subjects investigated and papers published.—L. A. Shaw.

The Relation between Fatigue and the Susceptibility of Guinea Pigs to Infections of Type 1 Pneumococcus. *Edith R. Nicholls* and *Reynold A. Spaeth.* Am. Jour. Hyg., Sept., 1922, 2, No. 5, 527-535.—It has been a quite commonly accepted belief that fatigue tends to increase susceptibility of individuals to disease. Evidence to prove this has not always been convincing, however, and experimental evidence in particular has been meager. Fatigue artificially induced in white rats and hooded rats has been shown definitely to increase rather than decrease their resistance to intraperitoneal injections of Type 1 pneumococcus. This paper gives the results of experiments showing that the same is true of guinea-pigs.

Throughout the experiments great care was exercised. The pigs, obtained from dealers, were held ten days or two weeks until they showed by their weight curves satisfactory adaptation to the new environment. They were then forced to run in motor-driven drums until exhausted, as shown by their failure to respond to ordinary exciting stimuli, such as pounding on the table or gentle handling. Every animal was subjected to three such running periods and injections of pneumococci were made in some cases before and in others after running. It was found in preliminary experiments that albino pigs were 300 per cent. more susceptible to such injections than pigmented pigs, and this relation was kept in mind during the main problem. The culture was carefully prepared.

Systematic autopsies were made, cases indicating secondary infections were rejected, and tabulated results included only deaths due without question to pneumococcal infections.

It was found that 80 per cent. of unfatigued animals died as the result of pneumococcal injections. On the other hand, 80 per cent. of animals fatigued as above and then subjected to injection lived. When the injection took place prior to fatigue 56 per cent. lived. These results corroborate the previous work on the relation between fatigue and susceptibility to Type 1 pneumococcus in white and hooded rats. Several charts and tables present the results in detail.—G. N. Thompson.

INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

The Functions of Medicine in Industry. *John A. Lapp.* Nation's Health, Nov. 15, 1922, 4, No. 11, 680-681.—Under the modern industrial regime the working environment must be adjusted to the workers, and the workers themselves, so far as possible, must be adjusted to their employment. These are the ends toward which industrial physicians must work, not alone, however, but as one department co-operating with the service department, the employment department, the department of social welfare, etc. Industrial medicine must be careful to establish itself on neutral ground by taking neither side and by establishing close communication with the human material with which it deals.—L. A. Shaw.

Industrial Morbidity and Accident Records. Nation's Health, Nov. 15, 1922, 4, No. 11, 678-679.—The fact that there is as yet no comprehensive and co-ordinated effort in record keeping in the medical departments of most otherwise progressive firms, led the Committee on Standardization of Records for Medical Service in Industry to formulate a logical grouping of the different items which must be considered in an intelligent analysis of morbidity and accident data. The items herein mentioned serve as a minimum amount of information to which more can be added at the discretion of individual plants. The proper grouping of these data is also shown in record form.—L. A. Shaw.

Dental Service for Employees. *Otto U. King.* Hosp. Management, Nov., 1922, 14, No. 5, 73-74.—Eight hundred million working days each year are lost to industry through ill health. A great deal of this is due to decayed teeth and diseased gums, which handicap men in converting food-energy into man-power and lead to a long list of diseases. Preventive dentistry is necessary to stop this vast amount of economic waste and physical suffering. So far it has had practical application through six different methods.

The first of these involves providing dispensaries for the children of employees, each having a corps of dentists and nurses who render treatment to children of less than 14 years, and carry a campaign of education into the home.

The second provides free treatment for all employees. Besides relieving pain, this also prevents much loss of time on the part of employees and furnishes an opportunity for teaching the proper care of the teeth.

A third variety is the furnishing of treatment through the co-operation of mutual aid associations and the employers, the expense being shared.

The fourth plan provides for dental treatment at cost, such treatment being rendered on the company's time and supplemented by educational literature.

The fifth involves the establishment of a co-operative self-paying clinic, organized by and for the employees, the object being to secure for themselves strictly high-grade work at a moderate price.

The sixth is the plan of Dr. Henry L. Banzhaf of Milwaukee, Wis., who has organized a co-operative dental clinic known as the Milwaukee Industrial Dental Clinic. It is the outcome of unsatisfactory attempts by large industrial concerns to have dental work done in their own establishments. Aside from educational work, its main feature is the maintenance of a large, centrally located dental office which sends out dentists at cer-

tain hours to each factory. There the employees needing attention are relieved of pain, given examination, and provided with mouth charts which serve as a guide either for their own dentist or the central office: at the latter place, through reduction in overhead expenses and specialization, a low fee for high-grade work is possible. Dr. Banzhaf says that this plan is the most feasible one for furnishing really high-grade work to the working man and his family.—G. N. Thompson.

INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

The Psychology of Employment. *C. O. Weber.* Abstracted from Administration, June, 1922, in Jour. Personnel Res., Sept., 1922, 1, No. 5, 270.—The author speaks of the great cost to any company of labor turnover, and of recruiting labor. This cost, he says, can be avoided by the use of correct employment principles. While physical tests and the personal interview are good methods of selecting employees, they do not measure capacities such as speed of visual perception, keenness of touch, auditory discrimination, etc. These capacities can only be determined by psychological tests.

The test must be devised for each type of worker to be hired. The procedure used is as follows:

1. A group of workers is selected and observed for a period of time as to output, errors, weaknesses, and strength.
2. The group is subjected to a series of mental and motor tests which it is believed will best determine the ability of each worker.
3. The coefficient of correlation between the actual practical ability of each worker and his test ability is determined.

If the coefficient of correlation is high, the test may be used to select applicants. With such a test the company eliminates applicants who will not make good.

Such tests have been used by some companies. They are not easy to devise, but once devised they are simple to handle. Their advantage lies in the fact that they indicate the presence or absence of capacities which otherwise would not be indicated for some time, and also that in a short while a great number of applicants can be examined.

INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

Court Decisions on Workmen's Compensation Law July, 1920-October, 1922. New York State Dept. Labor, Special Bull. No. 114, Dec., 1922, pp. 188.—Among the phases of the workmen's compensation law covered in this report are the following:

Treatment and care of injured employees.

Disability compensation.

Death benefits and dependency.

Waiting period.

Wages as the basis of compensation.

Payment of compensation—agreements, lump sums, etc.

Self-insurance.

Private insurance contracts.

Filing of compensation claims.

Election of remedies.

Subrogation of carrier in third party cases.

Notice of accident by employee to employer.

Presumption in favor of compensation claims.

Board's power to rescind or revise its awards and decisions.

SUBJECT INDEX TO VOLUME IV

This is a subject index to all the reading matter in the ABSTRACT OF THE LITERATURE OF INDUSTRIAL HYGIENE, and one should, therefore, look for the subject word. The name of the author follows the subject entry in parentheses.

For author index, see page 229.

AUTHOR INDEX TO VOLUME IV